UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL MARINE FISHERIES SERVICE
OFFICE OF ENFORCEMENT

BY: Marie M. Pallanzi

TITLE: Director, Office of Enforcement

DATE: August 27, 1992

UNITED STATES DEPARTMENT OF TRANSPORTATION
COMMANDANT
UNITED STATES COAST GUARD

BY: James H. Barbee

TITLE: Acting District Commander

DATE: September 18, 1992

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF CONSERVATION AND RESOURCES ENFORCEMENT

BY: William W. Paty

TITLE: Chairperson, Department of Land and Natural Resources

DATE: August 11, 1992

Appendix F

List of Military Activities in Hawaii

This compilation of classes of military activities conducted in Hawaiian waters has been divided into "near-shore" and "open ocean" categories. Near-shore operations are those which are conducted within the 100-fathom isobath proposed for inclusion in the sanctuary. Open ocean operations are those additional types of operations which are normally (but not always) conducted outside the 100-fathom isobath. These operations have been included because they are at times conducted near or inside the 100-fathom isobath. Theses classes of military activities near Hawaii are conducted by all the military services of the United States and, during combined operations, by military units from cooperating foreign nations or the State of Hawaii Department of Defense/National Guard.

I. SURFACE OPERATIONS

A. Near shore operations include, but are not limited to:

1. Pierside training and maintenance.
2. Dry-docking operations at Pearl Harbor.
3. Harbor movements by ships, submarines, boats and auxiliary craft.
4. Anchoring
5. Transit operations between harbors and operating areas (OPAREAS).
6. Salvage and towing operations.
7. Anti-submarine warfare (ASW) operations involving the use of sonar and expendable bathythermographs. Recoverable torpedoes are sometime used.
8. Amphibious warfare operations including the blasting of amphibious ships and the movement to the beach of landing craft, landing craft air cushion (LCAC), amphibious assault vehicles (AAV), ship's boats, special United States Marine Corps (USMC) "Boston Whaler" or "Zodiac" type special operations craft, and helicopters. Can involve the landings and take off of Harrier jets from a variety of amphibious ships.
9. Anti-surface warfare operations against ships and small boats
10. Special operations training involving swimmers and small boats
11. Explosive Ordnance Disposal (EOD) operations and training involving the use of explosives for demolition.
12. Mine warfare and mine counter-measure (MCM) operations involving the use of sonar, towed mine sweeping devices, the implantation of drill moored and bottom mines, and the firing of machine guns and small arms at floating targets.
13. Equipment and personnel drops from fixed wing and helicopter aircraft associated with re-supply, insertion, search and rescue and training.

B. Open ocean operations include, but are not limited to:

1. Transit operations between OPAREAs
2. Engineering, navigation, seamanship, and general warfare-related training exercises.
3. Towing operations.
4. Anti-submarine warfare operations involving the use of sonar, expendable bathythermographs , towed arrays and training torpedoes.
5. Amphibious warfare operations involving the blasting of ships over the horizon launch, recovery, and movements of LCAC and USMC/Seal special operations craft and low-flying helicopter and Harrier jet operations.
6. Anti-surface warfare operations involving high-speed maneuvering, the actual firing of guns and missiles at targets, calibration firing of guns and the launching of self-protective chaff.

7. Anti-air warfare operations involving the actual firing of guns and missiles at target craft and the launching of self -protective chaff and flares.
8. Replenishment operations to vessels underway involving the transfer of both supplies and fuel via wire and transfer of supplies by low-flying helicopters.
9. Supersonic flight above 5,000 feet and outside 25 miles from land.

II. SUBSURFACE OPERATIONS

A. Near-shore operations including, but are not limited to:

1. Transit operations to and from ports and OPAREAs.
2. Post maintenance shallow water divers.
3. Shallow water ASW and anti-ship operations, which include the expenditure of non-recoverable sonobuoys and smoke markers.
4. Torpedo exercises using retrievable non-explosive torpedoes.
5. Mine warfare training during which submarines traverse through a field of bottom-moored practice mines, using active sonar to detect and avoid mines.
6. ASW target services for ships and aircraft, which include the expenditure of non-recoverable sonobuoys and smoke markers and use of sonar and towed arrays.
7. Special operations involving swimmers operating from submerged submarines and supported by small boats.
8. Mine warfare training which includes the launching of recoverable exercise (inert) mines.

B. Open ocean operations including, but not limited to:

1. Transit operations at a variety of depths
2. Deep water dives and surfacing
3. Deep water ASW and anti-submarine/ship warfare operations involving the use of sonar, expendable bathythermographs, towed arrays, and training torpedoes.

III. AIR OPERATIONS

A. Near-shore operations including, but not limited to:

1. Landing and takeoffs by helicopters, fixed-wing aircraft and target drones from shore bases
2. Landings, takeoff and training flights at altitudes above 50 feet by helicopters from ships.
3. Training flights and transfers of personnel and equipment by helicopters and fixed-wing aircraft at altitudes above 50 feet. Low flying tactical helicopter and fixed-wing aircraft training flights (single and multi-ship, day, night unaided and Night Vision Goggle (NVG) training) often involve terrain-following and Nap Of the Earth (NOE) flight over or near the island and shorelines, as well as, flight in published FAA transitions below controlled airspace and flight traffic patters over water.
4. Air assaults by helicopters from amphibious ships at altitudes above 50 feet.
5. ASW operations from patrol (P-3) aircraft and helicopters, against actual submarines or mobile target at altitudes from 50 to 16,000 feet. Inert mines and missiles, non-retrievable sonobuoys and smoke markers and retrievable torpedoes are discharged into the water, Helicopters may use dipping sonar.
6. Bombing and missile firing exercises by fixed-wing aircraft of attack helicopters using surface target or Kaula rock.
7. Insertion/extraction of special forces/USMC Force Reconnaissance (RECON) troops from helicopters and fixed-wing aircraft into the water.

B. Open ocean operations including:

1. Aircraft carrier air operations.

2. Air combat maneuvering.
3. Live missile firings by aircraft versus target drones.
4. Live bombing, gunnery, and missile firings versus surface targets.
5. Low flying tactical helicopter and fixed-wing aircraft flights (single and multi-ship day, night unaided and NVG) transiting between island training areas at altitudes between 200 and 500 feet.
6. Emergency fuel dumping above 5,000 feet.
7. Air to air warfare operations involving the actual firing of guns and missiles at target craft and the launching of self-protective chaff and flares.
8. Supersonic flight above 5,000 feet and outside 25 miles of land.

OPERATIONS BY LOCATION

I. AREAS WITHIN ORIGINAL SANCTUARY BOUNDARIES:

A. PENGUIN BANK. Located southeast of Oahu, and southwest of Molokai, in the Kaiwi Channel. This is the areas of primary concern within the original sanctuary boundaries. Submarines conduct post-overhaul shallow- water dives in the vicinity of Penguin Bank. The area is also used for shallow-water ASW operations.

1. All Submarines completing any major repair work are required to conduct initial submerged testing in shallow water. The loss of USS THRESHER on sea trials generated the requirement to conduct initial submerged testing in shallow water to ensure that if the submarine has a casualty during the testing, and sinks to the ocean floor, the crew can be rescued. It is necessary to conduct initial testing close to shipyards facilities in case an unscheduled return to port is required for repairs. Penguin Bank is the only shallow water areas in Hawaiian water suitable for these required test.

2. Shallow-water ASW exercises involving surface ships and submarine, using low power active sonar transmissions, are conducted in the area to take advantage of the unique characteristics of shallow water. These exercise last from two to five days and result in the use of sonobuoys, smoke floats, expendable bathythermographs, and submarine-launched exercise (inert) torpedoes. This training cannot be conducted in deep water.

3. Submarines conduct mine warfare training at Penguin Bank. These exercises involve the submarines and small craft. The submarines practice implanting inert mine shapes, which are later recovered by small craft. This training cannot be conducted in deep water.

B. KAHOOLAWE. Operational training no longer conducted on Kaho'olawe. Helicopter operations occur regularly to and from the Navy bases camp for logistic purposes in support of the impending unexplored ordnance clean up. In addition helicopter flights will occur throughout the island for required aeromedical evacuation purposes. Landing craft are occasionally used to introduce or remove supplies and heavy equipment. Construction a pier is planned. The waters surrounding the island are not suitable for use by the public due to the presence of undetermined amounts of unexplored ordnance.

C. MAUI, MOLOKAI AND LANAI. With increased emphasis on littoral warfare, and the need to conduct training in shallow water, the waters adjacent to Maui, Molokai, and Lanai are important training areas for Navy ship home ported in Pearl Harbor. The channel between, Maui, Lanai and Molokai is extensively used for the biennial RIM PAC exercise as an EOD/MCM exercise area as well as for shallow-water ASW. Port visits are frequently conducted in Lahaina, Maui. Salvage ship and diving operations are frequently conducted.

1. The areas inside the 100 fathom isobath surrounding Maui, Molokai, and Lanai, and specifically the channel between this island, is used for shallow water ASW operations. These operations include

using low-power active sonar transmissions, sonobuoys, smoke floats, expendable bathythermographs, and exercise (inert) torpedoes.

2. This channel is also used for MCM training, including the use of bottom-moored practice (inert) mines, sonar, towed mine sweeping device and MCM surface ships.

3. The recent installation of the Hawaiian Area Tracking System (HATS) southeast of Lanai provides an excellent passive acoustic range for shallow water exercise torpedo firings. Exercise torpedo firings(non-explosive) are conducted with HATS range control utilizing a helicopter for range safety.

4. The waters surrounding Molokai are used by the Marines and the U.S. Army: USMC day/night helicopter operations focus predominantly in the area around Molokai, which is their only effective local night vision goggle (NVG) training area. These flights take place at altitudes above 50 feet. The U.S. Army also uses the Molokai training area (day, night unaided and NVG), and conducts flights in and around the shorelines of Maui and Molokai for low level training and for transit routes between Oahu and the major Army tactical training area on the island of Hawaii, Pohakuloa Training Area.

D. KAUAI. Few operations occur in the small area north of Kauai originally included in the sanctuary. Air operations sometime occur over this area, and transit operations sometime occur through it.

II. ADDITIONAL AREAS PROPOSED FOR INCLUSION:

A. KAUAI. A significant concern over the proposed inclusion of the remaining waters inside the 100- fathom isobaoth surrounding Kauai is the potential impact upon operations at the PMRF, located on Kauai. Operations below are subdivided by those occurring inside the 100-fathom isobath area proposed for inclusion, and those normally occurring outside it.

1. Operations inside the proposed sanctuary boundaries.

a. Airspace. The airspace above the 100-fathom isobath is frequently used by P-3 aircraft operating against actual submarines or mobile targets. Operations take place from 50 to 16,000 feet. Inert mines and missiles are discharged into the water. Other exercise material discharged includes non-retrievable smoke markers and sonbuoys, and retrievable torpedoes. Occasionally, due to equipment malfunction, retrievable torpedoes are lost at sea. Target drones are launched from PMRF through coastal airspace, Helicopter operations are conducted frequently in the near-shore area.

b. Surface. Amphibious exercises, involving landing craft, LCAC, and AMTRACs, are regularly conducted on the beaches at PMRF. Target recovery boasts pass through proposed sanctuary waters enroute to and from pick-ups. Missile and gun life firing exercises using air, subsurface and surface targets occur in area R-3101, a fully instrumented range which extends three nautical miles seaward from the western cost of Kauai, a portion of which is inside the 100-fathom isoboath. Area R-3101 also serves as an aerial target recovery area.

c. Subsurface. In addition to operations with P-3 aircraft, submarines conduct torpedo exercises using retrievable torpedoes, and mine warfare training. Submarine traverse through a field of bottom-moored mines, using active sonar to detect and avoid mines. During the course of these exercises, submarines discharge non-retrievable bathythermographs.

2. Operations adjacent to proposed sanctuary boundaries.

a. Airspace:

(1) Warning Area W-186 Special use airspace over open ocean located westward to northeastward of Kauai, and commencing at the border of R-3101, three nautical miles west of Barking Sands. Airspace extends from the surface to 9000 feet. W-186 is used for live missile, bomb, rocket, gunnery and torpedo exercises.

(2) Warning Area W-188. Special use airspace over open ocean located westward to northeastward of Kauai, and commencing at the border of R-3101, three nautical miles west of Barking Sands. The airspace extends from the surface to unlimited altitude and encompasses an operating area of approximately 42,000 square miles. W-188 is used for missile, rocket, gunnery, and torpedo exercises in support of fleet training and PMRF activities. The M-2, M-3, and M-4 portions of W-188 are a fully instrumented missile firing range with command and control, surveillance, tracking and telemetry services and data reduction services provided by and located at PMRF.

b. Surface: The surface of areas W-186 and W-188 encompass 41,000 square nautical miles, and are subdivided into eight operating areas for surface ships. Air, surface and underwater exercises using conventional ordnance of all types are conducted.

c. Subsurface:

(1) Barking Sands Tactical Underwater Range (BARSTUR): This range provides 80 square nautical miles of underwater tracking coverage in M2 of W-188, commencing seven nautical miles west of Kauai. The rage extends from the ocean floor to the surface. BARSTUR is used to evaluate ASW and anti-surface (ASU) warfare exercises and tactics and to track torpedo firings and submarines. The underwater and shore-based instrumentation at BARSTUR provides the capability to conduct ASW and ASU warfare training in an instrumented environment, which permits evaluation of the effectiveness of the tactics employed and the performance of weapons systems.

(2) Barking Sands Underwater Ranges Expansion (BSURE): This range is adjacent to BARSTUR and underlies M-4 in W-188. The range expands the underwater tracking area to approximately 800 square nautical miles, and extends from the ocean floor to the surface, BSURE is used to evaluate ASW and ASU exercises and to track torpedo firing and submarines.

B. OAHU

1. Operations inside proposed sanctuary boundaries.

a. Airfields generally. Low level day/night helicopter operations are conducted in accordance with published Federal Aviation Administration (FAA) routes/procedures and Honolulu approach control instructions for the various controlled and uncontrolled military and civilian airfields an the island of Oahu and the outer islands. FAA transition routing and/or training requires flight in and around the shorelines of Oahu at or below 500 feet.

b. Pearl Harbor. Operations within and near Pearl Harbor are primarily limited to transit operations, anchorages, ammunition on/off loads, maintenance, dry-docking, and pierside training.

c. Bellows Air Force Station. USMC and Navy special forces frequently use beaches at Bellow and adjacent water for amphibious operations. These exercises involve landing craft, LCAC, AAV, submarines with associated swimmer delivery vehicles and support craft, and small boat landings, as well as low level overflights by helicopters. The AMTRACs transit Kailua and Waimanalo Bays enroute to Bellows.

d. NAS Barbers Point. P-3 and other aircraft frequently overfly coastal water at low level on approach and takeoff. Helicopters and fixed wing aircraft overfly coastal waters at low level on approach and takeoff and during helicopter closed traffic operations south of the main runway.

e. Kaneohe Bay. Helicopters and fixed wing aircraft overfly coastal waters at low level on approach and take off. Small boats operate in the harbor.

f. Camp Smith Training Facility. Located in Ewa, just east of NAS Barbers point. Company-sized small boat raid exercises are conducted semiannually. These operations involve over the horizon launchings of small boats, which transit to and land on the beach.

g. Waianae Coast

(1) FORACS Range. Submarines conduct Fleet Operational Readiness Accuracy Check and Site (FORACS) operations off the Waianae coast to calibrate their sensors. These operations consist of slowly proceeding in a specified course and measuring sensor bearings to a sound source of known positions. The sound source is located within the 100-fathom isobath, as is a portion of the FORACS range.

(2) Dry-Deck Shelter (DDS) Operations. Submarines conduct dry-deck shelter operations in the leeward waters west of Oahu involving launching/retrieving of swimmers, swimmer delivery vehicles, and support craft from surfaced and submerged submarines.

(3) Pokai Bay. USMC parachute operations involving water landings are conducted on a quarterly basis at Pokai Bay, off Makua. These operations include personnel and small boat insertions, and include the dropping of non-recoverable smoke flares.

(4) Makua Valley Military Reservation. Army helicopter conduct frequent low level flights (200-500 feet) along the coast enroute from Wheeler AAF (from the north via Dillingham and Kaena Point or from the east via Kolekole Pass and NAVMAG Lualualei) and from NAS Barbers Point supporting air assault training and fire buckets operations. Makua Valley is inaccessible by air from the north, east and south due to the proximity of the Waianae mountains. It affords the only company level live fire training area on Oahu

h. Dillingham Airfield. Dillingham, the adjacent uncontrolled airspace on/off shore, and the published military helicopter training route are used extensively for night unaided and NVG training. Helicopters routinely overfly coastal water at low level during approach, takeoff, closed traffic operations, and air assault training at the Army training area abutting Dillingham.

i. A-311. Army helicopters frequently conduct day/night low level training flights between Wheeler AAF and the primary tactical training area on Oahu, alert area A-311. Adverse weather (low ceilings over the western edge of the Kahuku mountain range) often requires aircraft to divert, low level (200 to 500 feet) seaward of the North Shore enroute to A-311.

2. Operations adjacent to proposed sanctuary boundaries: The ocean areas and airspace north and south of the island of Oahu are divided onto a number of special operating areas in which live conventional ordnance firings are routinely conducted by surface ships and aircraft. Air tactics training is also routinely conducted at altitudes above 200 feet.

C. KAULA ROCK. An unattended/non instrumented target approximately 52 nautical miles southwest of Kauai. Kaula Rock is an island with an area of .7 by .5 nautical miles upon which inert ordnance may be expended on the first 1000 feet of the southeast tip. Air to ground training exercises expend inert conventional ordnance and night illumination devices. Oahu-based Army helicopters occasionally conduct

aerial gunnery training at Kaula Rock (W-187/R-3107). Operations entail open ocean and near-shore, low level, tactical flight (200-500 feet) enroute, and the expenditure of inert air-to-ground missiles and rockets on site.

D. HAWAII (ISLAND). Few operations occur inside the 100-fathom isobath surrounding Hawaii. Army and USMC helicopter operations regularly occur over the island, primarily in support of military exercises at the Pohkuloa Training Area (PTA) in the center of the island between the volcanoes, and enroute to/from home bases on Oahu. Navy and Army landing craft frequently on/off load supplies and equipment at Kawaihae Bay (Kawaihae docks) in support of military training at PTA. Navy ships conduct periodic port visits at Hilo and Kona.

GLOSSARY

AAF ..... Army airfield
AAV ..... Amphibious assault vehicles
AMTRACs ..... Amphibious-tracked landing vehicles
ASU ..... Anti-surface
ASW ..... Anti-submarine warfare
BARSTUR ..... Barking Sands Tactical Underwater Range
BSURE ..... Barking Sands Underwater Range Expansion
DDS ..... Dry deck shelter
EOD ..... Explosive ordnance disposal
FORACS ..... Fleet Operational Readiness Accuracy Check and Site
LCAC ..... Landing craft, air cushion
HATS ..... Hawaiian area tracking system
MCM ..... Mine counter-measure
NAS ..... Naval air station
NAVMAG ..... Naval Magazine
NVG ..... Night vision goggles
P-3 ..... Patrol aircraft
RECON ..... Reconnaissance
RIMPAC ..... Rim of the Pacific (Specific multi-national exercise)
OPAREAs ..... Operating areas
PMRF ..... Pacific Missile Range Facility, Barking Sands, Kauai
USMC ..... United States Marine Corps

THIS PAGE DELIBERATELY LEFT BLANK

Appendix G

ENVIRONMENTAL IMPACT
RESEARCH PROGRAM

TECHNICAL REPORT EL-89-10

SPECIES PROFILES: LIFE HISTORIES AND ENVIRONMENTAL REQUIREMENTS OF COASTAL VERTEBRATES AND INVERTEBRATES PACIFIC OCEAN REGION

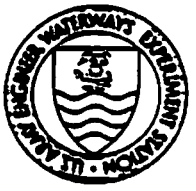
Report 2

HUMPBACK WHALE, *MEGAPTERA NOVAEANGLIAE*

by

Eugene T. Nitta, John J. Naughton

Southwest Region
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Honolulu, Hawaii 96822-2396

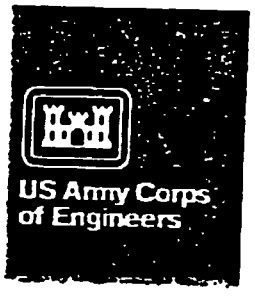


November 1989
Report 2 of a Series

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Monitored by Environmental Laboratory
US Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199



Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No 0704-0188 Exp Date Jun 30 1986

1a. REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY: Unclassified	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S): Technical Report EL-89-10
6a. NAME OF PERFORMING ORGANIZATION: See reverse. (6b. OFFICE SYMBOL (If applicable))	7a. NAME OF MONITORING ORGANIZATION: USAEWES Environmental Laboratory
6c. ADDRESS (City, State, and ZIP Code): See reverse.	7b. ADDRESS (City, State, and ZIP Code): 3909 Halls Ferry Road Vicksburg, MS 39180-6199
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: US Army Corps of Engineers (8b. OFFICE SYMBOL (If applicable))	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code): Washington, DC 20314-1000	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. / PROJECT NO / TASK NO. / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification): Species Profiles: Life Histories and Environmental Requirements of Coastal Vertebrates and Invertebrates, Pacific Ocean Region: Report 2, Humpback Whale, *Megaptera novaeangliae*

12. PERSONAL AUTHOR(S): Nitta, Eugene T.; Naughton, John J.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Report 2 of a series	FROM _____ TO _____	November 1989	29

16. SUPPLEMENTARY NOTATION: Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number): Environmental requirements; Life cycles; Hawaii; Humpback whale

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Commercial overexploitation resulted in the depletion of the North Pacific population of humpback whales. A major component of this population winters in Hawaiian waters, where reproductive activities occur. There are no apparent identifiable trends in the status of this population. This may be due to inconsistent survey efforts, the imprecision of survey techniques that are unable to detect small changes, no measurable trend, or one or any combination of these factors. During the winter breeding season, humpback whales are found within the 100-fathom isobath and shallower waters around the main Hawaiian Islands. Cow-calf pairs, in particular, demonstrate an affinity for waters of less than 50 fathoms. It appears that size, depth, and substrate of shallow bank areas are important elements in the distribution of humpback whales on their wintering grounds. The sea-surface temperature in Hawaiian waters ranges from 23.2° to 24.2° C during the winter breeding season and is at the low range of water temperatures in comparison with breeding areas in other parts of the

(Continued)

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code) / 22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

Unclassified

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

6a. & c. NAME AND ADDRESS OF PERFORMING ORGANIZATION (Continued).

National Marine Fisheries Service, NOAA
Southwest Region
Honolulu, HI 96822-2396

19. ABSTRACT (Continued).

world. The major environmental impact facing humpback whales in Hawaiian waters is the loss and modification of shallow nearshore habitat to harbor, resort, and other coastal development; and the subsequent increase in human activity including vessel traffic, which may result in disturbance and displacement of humpback whales from preferred habitat.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

PREFACE

This report was published as part of the Environmental Impact Research Program (EIRP), sponsored by Headquarters, US Army Corps of Engineers (HQUSACE). Partial funding was provided by the US Army Engineer District, Honolulu. Technical Monitors were Dr. John Bushman, Mr. David P. Buelow, and Mr. Dave Mathis of HQUSACE. Dr. Roger T. Saucier, Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES), was EIRP Program Manager.

This report is designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the humpback whale, *Megaptera novaeangliae*, and to describe how populations of the species in the Hawaiian waters may be expected to react to environmental changes caused by coastal development. The report has sections on taxonomy, life history, ecological role, environmental requirements, growth, exploitation, and management. The report was prepared by Messrs. Eugene T. Nitta and John J. Naughton of the Southwest Region, National Marine Fisheries Service (NMFS), under support agreement WESCW88-241.

Dr. C. Scott Baker, National Cancer Institute, Department of Health and Human Services; Dr. James D. Darling and Ms. Elizabeth Mathews, West Coast Whale Research Foundation, Vancouver, B.C.; Dr. Dale Rice and Ms. Sally Mizroch, National Marine Mammal Laboratory, NMFS; Dr. Gerald Scott, Miami Laboratory, Southwest Fisheries Center, NMFS; and Mr. Michael T. Lee, US Army Engineer District, Honolulu, provided reviews of the manuscript. Mr. Allan Wolman, National Marine Mammal Laboratory, NMFS, and Dr. Darling provided additional unpublished data.

Mr. Edward J. Pullen, Coastal Ecology Group, EL, served as Contract Monitor for this study under the general supervision of Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL, and Dr. John Harrison, Chief, EL, WES.

COL Larry B. Fulton, EN, was Commander and Director of WES. Dr. Robert W. Whalin was Technical Director.

This report should be cited as follows:

Nitta, Eugene T., and Naughton, John J. 1989. "Species Profiles: Life Histories and Environmental Requirements of Coastal Vertebrates and Invertebrates, Pacific Ocean Region; Report 2, Humpback Whale, *Megaptera novaeangliae*," Technical Report EL-89-10, prepared by National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Honolulu, HI, for the US Army Engineer Waterways Experiment Station, MS.

CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters (m)	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers (km)	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters (m^3)	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons (t)	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (°C)	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
pounds (lb)	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (°F)	0.5556 (°F - 32)	Celsius degrees

CONTENTS

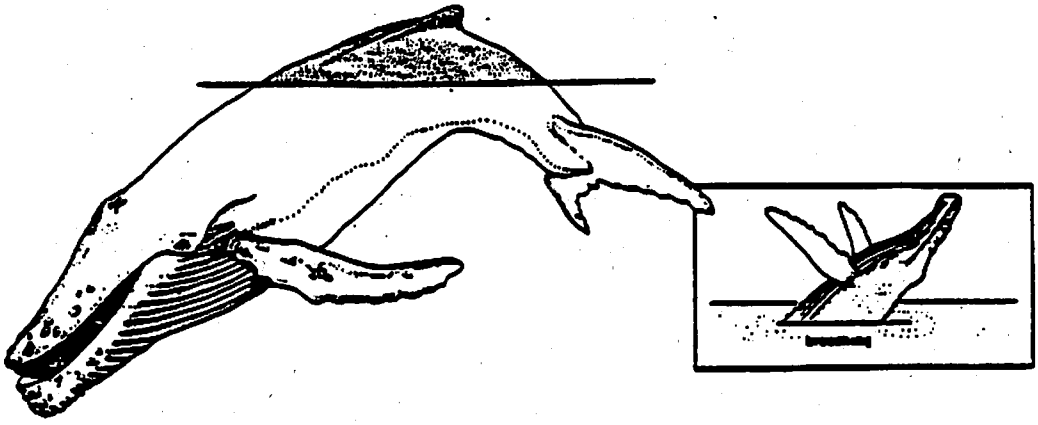


Figure 1. Humpback whale
(Northwest Fisheries Center, National Marine Fisheries Service)

THE NORTH PACIFIC HUMPBACK WHALE IN HAWAIIAN WATERS

NOMENCLATURE, TAXONOMY, AND RANGE

Scientific name.....Megaptera novaeangliae (Borowoski, 1781)
Preferred common name ..... Humpback whale (Figure 1)
Other common names .. Humpbacked whale
Class ..... Mammalia
Order .....Cetacea
Suborder ..... Mysticeti
Family ..... Balaenopteridae

Geographic range: Worldwide. In the North Pacific, winters in shallow nearshore waters of usually 100 fathoms or less around the Ryukyu and Bonin Islands of Japan and Taiwan in the western North Pacific; main Hawaiian Islands in the central North Pacific; the coast and offshore islands of central Baja California to Cabo San Lucas and the southern Gulf of California; and off mainland Mexico from Sonora to Jalisco, and the Revillagigedo Islands (Socorro, San Benedicto, and Clarión). Distribution over the summer feeding grounds ranges from the coasts of Honshu, Japan, and southern California north to the Chukchi Sea (for distribution in the Hawaiian Archipelago, see Figure 2).

MORPHOLOGY AND IDENTIFICATION

Humpback whales are medium-sized rorquals, with adult females larger (average = 14 m) than males (average = 13 m). In comparison with other balaenopterids such as fin whales

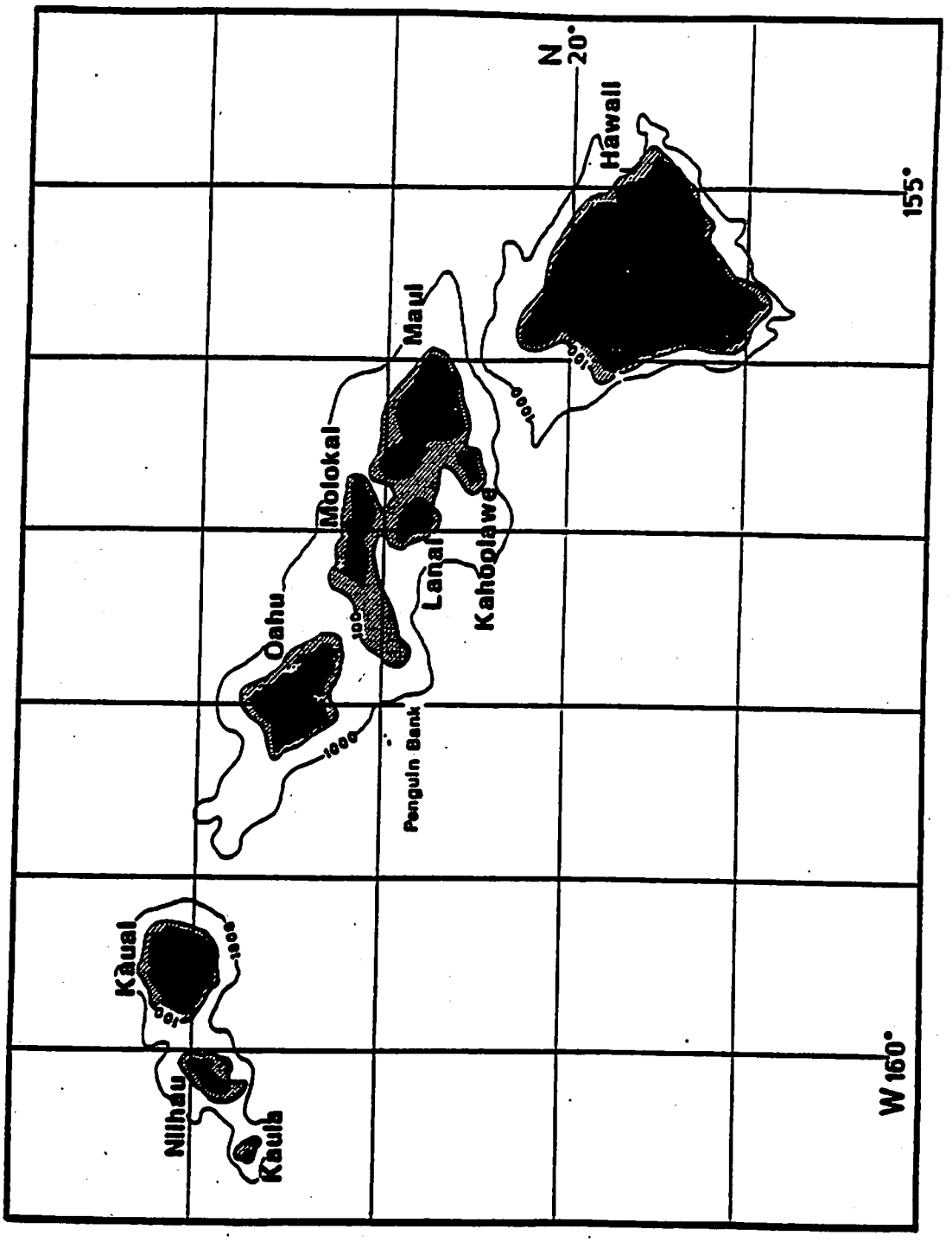


Figure 2. Distribution of humpback whales in Hawaiian waters (depths in fathoms).

2

(Balaenoptera physalus) or sei whales (B. borealis), humpback whales are more full-bodied (Leatherwood and Reeves 1983). When viewed from above, the head is broad, much like that of a blue whale (B. musculus). The dorsal aspect of the head is distinctive with a number of fleshy knobs or tubercules distributed from the tip of the snout to the blowhole and along the sides of the lower jaws. Each one of these fleshy knobs supports at least one tactile hair. In lateral view, the head is surprisingly slim and can resemble an alligator in profile. Paired blowholes are characteristic of baleen whales, and the humpback whale's pear-shaped blow reaches heights of 2 m or higher.

The long flippers are characteristic of humpback whales, measuring nearly one-third the length of the body; the front edge bears a series of knobs and is irregularly scalloped. Ventral grooves, which number from 14 to about 22, extend from the chin to the navel (Leatherwood et al. 1982). The dorsal fin is located less than one-third of the body length from the fluke notch and slightly behind the intersection of the anus (Nishiwaki 1972). It is relatively small and ranges from a distinct falcate fin to a small triangular nubbin. The dorsal fin is often associated with a step or hump which is accentuated when the animal dives, from which the animal derives its common name (Leatherwood and Reeves 1983). The width of the flukes are one-third the total body length and are serrated or scalloped along the trailing edge. Coloration of the dorsal aspect of the flukes is usually dark. The flukes' ventral surface ranges from completely black to almost totally white, with numerous scar patterns and other natural markings allowing identification of individual animals over time.

Humpback whales are basically dark gray to black. The ventral surface is variably white, with a white patch along the ventral midline to the anus. The undersides of the flippers are always white; the upper surface varies from mostly black to white (Leatherwood and Reeves 1983).

The relatively short baleen plates number from 270 to 400 and are generally blackish with gray fringes.

The vertebral formula is C7 + T14 + L10 + Ca21-22 = 52-53. The flippers have four fingers of I: 2, II:7, IV: 6, V: 3 (Nishiwaki 1965, 1972).

REASON FOR INCLUSION IN SERIES

The coastal habitat of the humpback whale made it one of the most vulnerable species to modern whaling. Overexploitation resulted in the worldwide depletion of most stocks of humpback whales. The International Whaling Commission (IWC) banned the commercial harvest of humpback whales in the North Atlantic in 1955, the North Pacific in 1965, and the Southern Hemisphere in 1966. In 1970 humpback whales were listed as an endangered species under the Endangered Species Conservation Act of 1969. All stocks of humpback whales remain listed as endangered under the Endangered Species Act of 1973, as amended.

The wintering grounds of some stocks lie within the territorial waters of non-IWC member countries, and a few animals are taken annually in aboriginal hunts. Humpback whales are also increasingly subject to seabed mining and oil and gas recovery activities, nearshore pollution, ocean dumping, entanglement in fishing gear, coastal and tourist-related development such as marinas, harbors, and resorts, and vessel traffic. These factors affect competition for and the availability of prey resources, and habitat availability. Each activity has the potential for direct disturbance (i.e., harassment) of individual whales or an indirect impact through damage to habitat or both.

Although humpback whales are protected from direct exploitation on a large scale, population estimates remain uncertain and low, and recovery rates are unknown. Furthermore, the species' dependence on coastal habitats for calving, rearing, courtship, and feeding suggest that recovery may be negatively affected by the continuing degradation of these habitats. Habitat loss and modification can have a particularly acute impact in coastal wintering grounds associated with islands or island groups such as Hawaii, where preferred humpback whale habitat is limited and displacement into suboptimal areas may occur due to extensive human activities.

LIFE HISTORY AND ECOLOGY

Reproduction and Recruitment

Age at sexual maturity for both male and female humpback whales has been estimated from 5 years (Nishiwaki 1959; Chittleborough 1965) up to 9 years (Johnson and Wolman 1984). Glockner-Ferrari and Ferrari (1987) report a known-age male of 7 years actively participating in apparent courtship behavior in Hawaii. More recently Clapham and Mayo (1987) report known-age females with calves at 4 and 6 years, respectively, observed in Massachusetts Bay (Gulf of Maine), inferring age at sexual maturity at 3 and 5 years for these individuals. Nishiwaki (1965) reported length at sexual maturity for females at 11.4 - 12.0 m, and 11.1 - 11.4 m for males.

As seasonal breeders, humpback whales have reproductive cycles that are closely tied to their seasonal migrations. Mature females are believed to conceive on the breeding grounds one winter and give birth the following winter. Gestation lasts about 12 months. A few known females have produced a calf in successive years on the Hawaiian wintering grounds (Glockner-Ferrari and Ferrari 1987), but the usual reproductive cycle appears to be 2 or more years. Chittleborough (1958) examined Norwegian Antarctic whaling records for females selectively taken in commercial whaling operations from 1950 to 1955. He noted that 8.5% of the sexually mature females were both pregnant and lactating and, thus, must have mated shortly after giving birth. The survival rate of calves from annual breeders is not known.

In the Northern Hemisphere births usually occur between January and April. Calves are about 4 m to 5 m long at birth and colored light gray (Chittleborough 1958; Nishiwaki 1959; Leatherwood and Reeves 1983). The single calf is nursed for 10 to 11 months and is about 8 to 9 m long at weaning after completing one migration to the summer feeding grounds with its mother.

Estimates of calving rates for Hawaii range from 0.29 to 0.58 (calves per mature female per year) on the basis of resighting data and aerial survey data (Herman and Antinoja 1977; Baker, Perry, and Herman, in press). Baker, Perry, and Herman in press) suggest that an overall calving rate of 0.37 for the Hawaiian population is most accurate, with mature females averaging every 2.7 years the birth of a calf that survives its first 6 months of life and its first migration. Forestell (in prep.) found that of 347 whales sighted between January and April 1985, 35 (10%) were calves.

Mating Behavior

Humpback whale behavior on the Hawaiian wintering grounds strongly suggests that both calving and mating occur in or near these waters. Analysis of ovaries and testes from humpback whales taken in commercial whaling operations (Chittleborough 1958) and estimates of the length of gestation indicate that the months of assembly in Hawaii include the peak of the mating period. Though neither

calving nor mating has actually been observed, cows with very young calves are commonly sighted in shallow, near-shore, protected waters less than 10 fathoms in depth and often very close to shore or the outer reef. Aggressive and apparent agonistic behavior among males presumably for access to potentially receptive females, and pairing and consort behavior between males and females have been detailed by Baker, Herman, and Stifel (1981); Darling (1983); Tyack and Whitehead (1983); Baker and Herman (1984); and Glockner-Ferrari and Ferrari (1985). Females probably come into estrus within a 3- to 4- month period while wintering in Hawaiian waters (Darling 1983). Cuts and abrasions are inflicted by males on each other, with head butts, flipper slaps, peduncle slaps, breeches, and other aggressive behaviors during competition for access to females (Baker and Herman 1984; Johnson and Wolman 1984).

Commonly observed group or unit compositions on the winter grounds include: cow with calf, often escorted by a male; lone singers (males); lone adults; pairs of adults (male-male, male-female); and larger groups (multiple males and a female). There is a regular interchange of individuals between and among these groups that occurs over hours or days, except for cow-calf pairs (Mobley and Herman 1981; Baker and Herman 1984; Mobley and Herman 1985; J.D. Darling, 1988, West Coast Whale Research Foundation, Vancouver, B.C., pers. commun.)

Vocalizations

On the winter breeding grounds, humpback whales produce "songs" which have been described as a series of repeating, complex sequence of sounds including whistles, chirps, squeals, and grunts organized into phrases or syllables within a phrase (Payne, Tyack, and Payne 1983). The frequency range of these songs is generally less than 4 kHz (Payne and McVay 1971; Thompson, Winn, and Perkins 1979; Payne and Guinee 1983). A number of singers have been identified as males, and it has been hypothesized that, among other uses, these humpback whale songs function as acoustic displays demonstrating dominance (Darling 1983; Darling and Morowitz 1986) and/or availability (Tyack 1981; Baker and Herman 1984). Some males also remain longer on the breeding grounds than other males and females, suggesting that they may be dominant males staying as long as females come into estrus (Darling 1983).

"Social sounds" are nonsong vocalizations produced on the winter breeding grounds and are thought to be associated with agonistic behavior within large, surface active pods of humpbacks. These social sounds do not possess the complex structure of songs with their peak energy between 1- to 3-kHz and the frequency range usually below 4.7 kHz (Tyack 1983; Mobley, Herman, and Frankel 1986; Silber, in press; A. Frankel, 1988, Kewalo Basin Marine Mammal Laboratory, University of Hawaii, pers. commun.).

A third type of stereotyped vocalization, the "feeding call," has been recorded during the summer months in the vicinity of feeding whales in southeastern Alaskan waters (Baker 1985). It is described as a "highly stereotyped series of trumpeting calls, each of approximately 2 sec in length, with a frequency range of 440 to 550 kHz" (Baker 1985; Mobley, Herman, and Frankel 1986).

Natural Mortality

Mizroch (1985) notes natural mortality estimates for North Pacific humpback whales of 0.05 - 0.08 as reported by Ohsumi (1979) from Doi, Nemoto, and Ohsumi (1967). Neither the method of estimation nor sample size was reported.

Large sharks, such as great whites (Carcharodon carcharias) and tigers (Galeocerdo cuvieri), and kill-

er whales (Orcinus orca) are probably responsible for a large proportion of the natural mortality of calves and old or ailing adults. Large tiger sharks were observed consuming a humpback whale calf near Molokini Island. Whether the sharks killed the calf first or were just feeding on the carcass was not determined (Shallenberger 1981). During the Cooperative Shark Research and Control Program conducted by the University of Hawaii around the Hawaiian Islands in 1967-69, 6% of the tiger sharks caught had large whale and small odontocete remains in their stomachs (Tester 1969).

In higher latitudes, humpback whales that frequent the edge of ice fields are sometimes trapped in the ice. (Lien at al 1983).

In late 1987 and early 1988, a large number of mysticete whales died and came ashore in the Cape Cod area. A total of 15 humpback whales, 4 minke whales (Balaeanoptera acutorostrata), and 2 fin whales (B. physalus) were included in this episode. Testing of mackerel found in the stomachs of the animals sampled showed the presence of a toxin with effects similar to that of paralytic shellfish poison biotoxins. This is the first instance in which a biotoxin has been implicated in large whale mortality (D.W. Beach, 1988, Northeast Region, National Marine Fisheries Service, pers. commun.).

Ectoparasites and Commensals

Although humpback whales are infested with various ectoparasites and commensals, they rarely manifest a debilitating reaction. Barnacles are large and conspicuous over certain parts of the body. They tend to concentrate along areas of high turbulence, such as the flukes, the leading edge of the dorsal fin and flipper, or along the midline of the ventral pleats. Smaller whale lice (cyamid crustaceans) are distributed around barnacles and in depressions and folds in the skin. Cookiecutter sharks (Isistius spp.) and lampreys cause some skin and blubber damage which probably result in some scarring.

Accidental Mortality

Humpback whales can become entangled in various types of fixed fishing gear, including fish weirs and traps, lobster trap lines, buoy lines, and gill and trammel nets. These incidents have occurred mainly off the northeastern United States and eastern Canada, and most injuries and mortalities are reported from these areas (Perkins and Beamish 1979; Lien and Aldrich 1982; Lien et al. 1982; Lien et al. 1983; Lien, Walter, and Harvey-Clark 1985; T. MacKenzie, 1989, Northeast Region, National Marine Fisheries Service, pers. commun.)

Another source of injuries and accidental mortalities are collisions with vessels. Since 1986, a near miss and two collisions have been documented in Hawaiian waters (Siler 1987; Stevens 1988; Tanji 1988). Collisions are likely to occur with greater frequency where high speed vessel traffic is increasing in areas of high whale concentrations, such as off the leeward coast of Maui and to a lesser extent off Kailua-Kona on the Island of Hawaii and the south shore of Oahu.

Feeding

Summer feeding areas occur across the Pacific, from the Aleutian Islands to the Farallon Islands off central California. In the Northern Hemisphere the diet of humpback whales consists of pelagic organisms of the coastal zone. These include mainly krill (euphausiids) along with schooling fishes such as herring, Clupeidae; sand lance, Ammodytes sp.; capelin, Mallotus villous; juvenile salmonids, Onchorhynchus spp.; Arctic cod, Boreogadus saida; walleye pollock, Pollachius virens; and anchovies, Engraulis mordax; rarely cope-

pods, pteropods and cephalopod mollusks (Wing and Krieger 1983, unpub. manuscr., Auke Bay Laboratory, National Marine Fisheries Service, NMFS, Auke Bay, AK; Johnson and Wolman 1984; Krieger and Wing 1984). Humpback whales are found to be heavily clumped in their distributions relative to prey abundance (Johnson and Wolman 1984).

Isolated incidents of apparent feeding and observations of defecation by humpback whales have been noted in Hawaii. Schooling carangids (opelu, Decapterus macarellus and akule, Selar crumenopthalmus) occur in large aggregations within Hawaiian waters frequented by humpback whales; however, there have been no confirmed sightings of humpback whales feeding on these potential prey species. Humpback whales are not known to regularly feed in Hawaiian waters (Glockner-Ferrari and Ferrari 1985).

Humpback whales feed at the surface down to about 150 m (Dolphin 1987). Feeding techniques have been described as skimming, lunge feeding, and circular swimming (Jurasz and Jurasz 1979). Bubble net feeding is an interesting behavior in which a submerged whale releases a stream of bubbles in patterns ranging from lines and partial circles to complete circles with "tails." The animal then rises through the concentration of prey with its mouth open. Various levels of apparent cooperation during bouts of feeding have also been observed, including herding of prey (Baker and Herman 1985).

EXPLOITATION AND POPULATION SIZE

History of Exploitation

An unknown number of humpback whales were taken by aboriginal hunters and commercial whalers prior to 1900 in the North Pacific. During the course of modern whaling from 1905 to 1960 in the eastern Pacific and 1889 to 1960 in the western Pacific, approximately 23,000 humpbacks were taken. Between 1960 and 1965, more than 5,000 were killed in commercial whaling operations reducing the North Pacific population to about 1,000 (Rice 1978).

Current and Initial Stock Sizes

The preexploitation size of the North Pacific population of humpback whales prior to 1905 was estimated to be about 15,000 animals (Rice 1978). A recent estimate of the North Pacific population of 2,100 is based on a mark and recapture estimate derived from individual sightings of animals over a 4-year period (Darling and Morowitz 1986). Estimates for the Hawaiian stock range from 550-790 to 2,100 (Rice and Wolman 1979, unpub. manuscr. submitted to IWC Scientific Committee; Baker et al. 1986; Darling and Morowitz 1986). The wide range of estimates is likely due to differences in analysis of mark and recapture data and survey techniques. Until more data are available, these estimates should be used with considerable caution (Table 1).

Minimum counts based on the total number of unique individuals identified over a specified period of time have also been developed. These range from 521 individuals for one year in 1981, to 922 over 4 years from 1977 to 1981 (Darling and Morowitz 1986). Perry et al. (1988) identified 1,140 unique individual humpback whales over a 9-year period (1977-1985) for the Central and eastern North Pacific. These counts do not account for mortality or recruitment and should not be considered abundance estimates.

Estimates for the wintering stocks in Mexico and the western Pacific are as yet unavailable, though numbers have been speculated to be in the hundreds or less. During the winter and spring of 1986, more than 100 individual humpbacks were photographically identified in waters

Table 1. Humpback whale abundance estimates — Hawaii and the North Pacific.

Method	Count or Estimate	Time Frame	Area	Source
Photo-I.D. Minimum Count	1140 635	1977-1985 1977-1985	E.N. Pacific Hawaii	Perry et al. 1988
	521 922	1981 1977-1981	Hawaii Hawaii	Darling and Morowitz 1986
Modified Bernoulli Estimate	1000 2100	1981 1977-1981	Hawaii Hawaii and E.N. Pacific	Darling and Morowitz 1986
Petersen Estimate	1627 (±307)	1977-1983	Hawaii	Baker et al. 1986
Weighted Petersen Estimate	1407 (±294)	1980-1983	Hawaii	Baker and Herman 1987
Vessel Survey	550-790	1976-1979	Hawaii	Rice and Wolman 1979 (unpub.)
Aerial Survey	900 (±150)	1985	Hawaii	Forestell (in press)

around Isla Socorro and Isla Isabel off Mexico, indicating a larger population than previously believed (Urban and Aguayo 1987). In the late winter of 1988, 15 humpback whales were identified, including at least 3 with new calves, in the Bonin Islands south of Japan. Five humpback whales were photographed in 1987, but not seen in 1988, resulting in a total of 20 identified individuals. A rough estimate of abundance based on available information indicates a population "at least in the low hundreds" for this area (Darling and Ford 1988). There is no current information regarding abundance of humpback whales from the other western North Pacific wintering areas off the Mariana Islands, Ryukyu Islands, and Taiwan.

DISTRIBUTION

Migration

In Australia, Dawbin (1966) found that humpback whales do not require coastal conditions for migration. Migration routes could not be related consistently to the direction of ocean currents, the nature of water masses, or bottom topography.

Humpback whales begin arriving in Hawaiian waters as early as October, though the season is more commonly thought of as beginning in December. Baker et al. (1985) reported a minimum known migration time of 79 days between Alaska and Hawaii based on resighting data. A peak in relative numbers of whales occurs in February (Herman, Forestell, and Antinoja 1980; Forestell, in press). Baker and Herman (1981) found that from 1977 to 1979 the Island of Hawaii showed the earliest peak influx of whales, with islands to the northwest showing progressively later dates of peak residency. Most whales depart by the end of April, though a few may stay through early June (Herman, Forestell, and Antinoja 1980).

The average duration of wintering in Hawaii for either sex of any age class is unknown. Glockner-Ferrari and Ferrari (1985) reported a maximum known cow-calf residency interval in Hawaii of 56 days. Dawbin (1966) found a succession in the migration to colder waters by different segments of the population, with an early departure of females without calves. In Hawaii, females with calves tend to be the last to leave the wintering grounds (Herman, Forestell, and Antinoja 1980).

Seasonal Habitats and Stock Structure

Individual whales wintering in Hawaii have been identified in the Gulf of Alaska (Kodiak Island, Prince William Sound, and Yakutat Bay), southeastern Alaska (Darling and McSweeney 1985; Baker et al. 1986), and the Farallon Islands off California (Baker et al. 1986) during the summer. While humpback whales have been observed in southeastern Alaska in all months of the year, no one individual has yet been documented to overwinter or stay year-round (Straley, in press). Two individuals have also been identified wintering in Hawaii during one year and in Mexico in another year (Darling and McSweeney 1985; Baker et al. 1986). Darling and McSweeney (1985) suggest that, because of these migratory connections, all humpback whales in the eastern North Pacific are of the same stock. Baker et al. (1986) also propose that humpback whales in the eastern and central North Pacific are of one stock and form several geographically isolated feeding herds. These authors define the term "structured stock" as several feeding herds that intermingle to breed on one or more wintering grounds.

HABITAT USE

In general, humpback whale distribution in Hawaii appears to be limited to the 100-fathom (183 m) isobath and shallower waters. (Figure 2).

Surveys in the late 1970's (Wolman and Jurasz 1977; Rice and Wolman 1979, unpubl. manuscr. submitted to IWC Scientific Committee; Herman, Forestell, and Antinoja 1980) showed that humpback whales prefer certain areas over others in Hawaii. The area of greatest use was found to be the four-island area (Maui, Molokai, Lanai, Kahoolawe) and Penguin Bank. Also heavily utilized were the Island of Niihau and the Island of Hawaii, Keahole Point north to Upolu Point (Figure 3). Kauai, Oahu, and the eastern and southwestern waters of the Island of Hawaii received substantially less usage. Kaula Island, just southwest of Niihau appears to mark the western limit of humpback whale distribution in Hawaii, as few animals have been reported around the atolls,

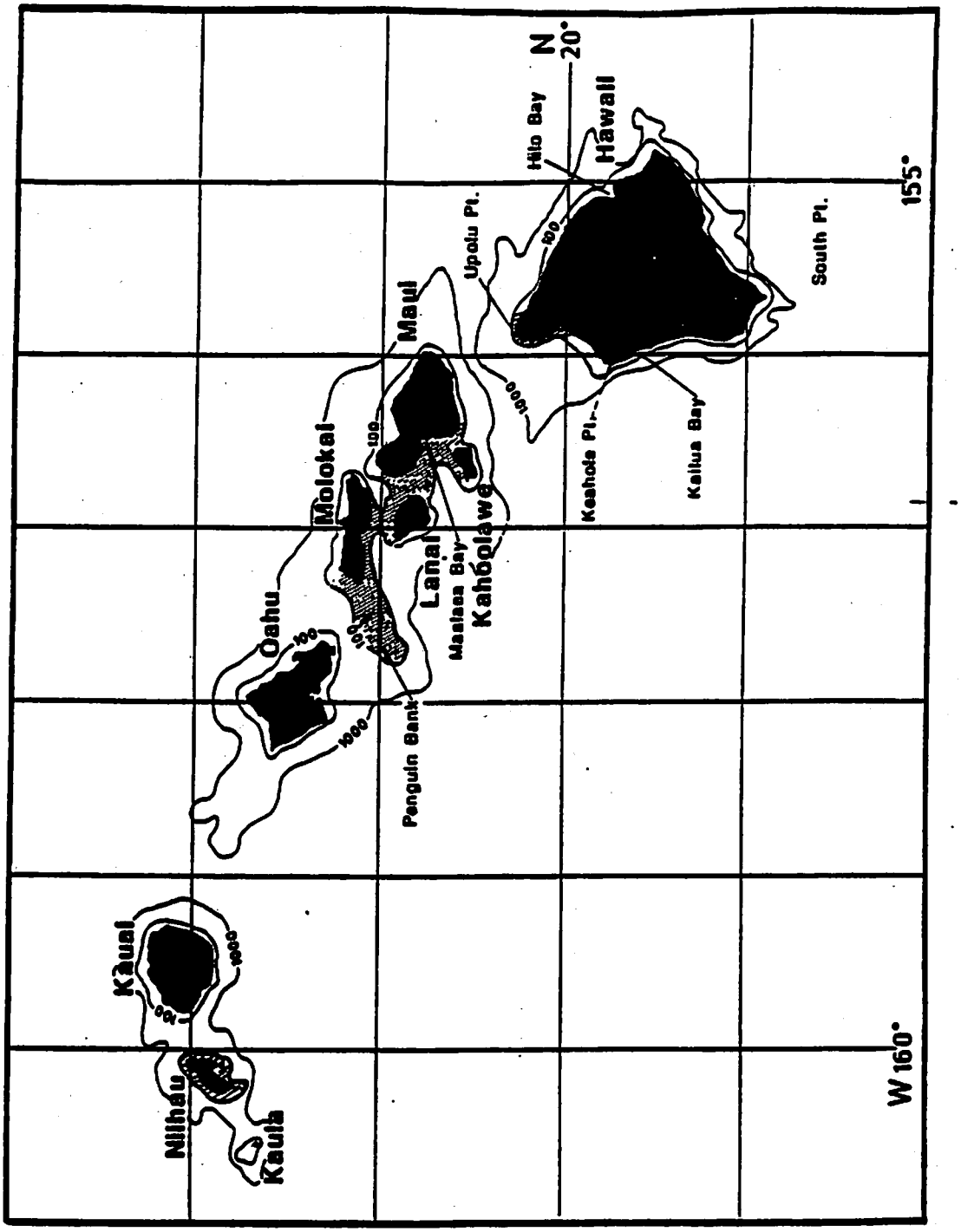


Figure 3. Areas of reported high density of humpback whales (depths in fathoms).

islands, banks, and reefs of the northwestern Hawaiian Islands. Although all-island surveys have not been undertaken since 1979, indications are that this general usage pattern has remained fairly consistent. Fluctuations in relative abundance within and between islands occasionally occur.

Humpback whales are known to use the waters of Hawaii to nurse their young. In addition, calving, courtship, and mating are thought to occur in or near Hawaii, though confirmed sightings of these behaviors have not been observed to date. Aggressive male-male competition for sexually mature females, including cows with calves, is evident throughout the season in Hawaii (Baker and Herman 1984). Cows with newborn calves are commonly found throughout the winter, and general areas of high usage by these pairs have been observed. Herman, Forestell, and Antinoja (1980) defined the north coast of Lanai as an area of high cow-calf density. Hudnall (1978) suggested Maalaea Bay, Maui, as a major nursery area. Glockner-Ferrari and Ferrari (1985) characterized the southwest coast of Maui from MacGregor Point to Kaanapali as an area of high-calf use. Forestell (in press) found roughly three times as many total calves in the four island area as over Penguin Bank during aerial surveys.

ENVIRONMENTAL REQUIREMENTS

Humpback whales are strongly migratory, though routes between winter calving areas and summer feeding grounds are not well known. Humpback whales occur very close to shore and appear to be relatively sedentary once they arrive at their northern or southern seasonal destination (Leatherwood et al. 1982). Because of this behavior, they appear to have specific environmental requirements more closely associated with land masses than do any other species of large whales with the exception of the gray whale (Eschrictius robustus). Humpback whales also are affected by human activity to a greater degree than other balaenopterids.

Water Depth

The distribution of humpback whales during winter is almost exclusively over relatively shallow banks. Winn, Edel, and Taruski (1975) found that 99% of the sightings of humpback whales in the West Indies are found on banks between the 10- and 100-fathom (18 and 183 m) line. Whitehead and Moore (1982) narrow this down further by stating that humpback whales in the West Indies principally winter in waters between 15 and 60 m deep.

The same affinity for banks occurs in humpback whales wintering in Hawaiian waters (Figure 3). Wolman and Jurasz (1977) found that of 373 whales sighted in Hawaiian waters, only 7 were in deep interisland channels or in water deeper than 92 m. In a subsequent vessel survey, Rice and Wolman (1979, unpub. manuscr. submitted to the IWC Scientific Committee) sighted only 2 out of 411 humpback whales in waters deeper than 180 m. Tinney (1988) states that whales in Hawaii tend to favor water about 25 fathoms (46 m) in depth.

Off windward Oahu, adult humpback whales have been observed on several occasions swimming slowly parallel to but just seaward of the 10-fathom (18 m) isobath where a sharp sea bottom escarpment drops from 10 to approximately 15 fathoms (18 to 27 m) (J. Naughton, Southwest Region, National Marine Fisheries Service, Honolulu, pers. obs.). The whales appear to follow the depth contour as they migrate along the coastline.

Glockner-Ferrari and Ferrari (1985) report that of the mothers and calves they recorded off Maui in 1977 and 1979, 80.3% were within the 10-fathom (18 m) curve. Glockner and Venus (1983) found mothers and calves

resting in shallow waters often just beyond the surf line. In a study in Maalaea Bay, Maui, by Muller, Carini, and Hudnall (1980 unpub. manuscr., Maui Whale Research Institute), most whales were observed in water 25 to 73 m deep. The only calves seen were in water estimated to be less than 18 m deep. High cow-calf densities relative to other age classes of whales at specific sites off the west coast of the Island of Hawaii have also been noted. These areas include waters shallower than 50 fathoms (91 m) between Keahole Point and Kiholo Bay, and from Keahuolu Point to Kailua Bay (M. Smultea 1988, Moss Landing Marine Laboratory, pers. commun.; E. Mathews and D. McSweeney 1988, West Coast Whale Research Foundation, pers. commun.). Compared with other age/sex classes of the population, the data indicate that mothers and calves prefer shallower waters. Cows with newborn calves tend to segregate themselves from other whales as well as from other cows and calves. This suggests that females with calves need substantial areas of shallow water in which to swim, rest, and presumably nurse (Tinney 1988).

Bank Characteristics

A. Size

In addition to water depth, the size of the bank appears to be of importance to humpback whales on their wintering grounds. Winn, Edel, and Taruski (1975) found that in West Indies waters, coasts with narrow shelves, generally less than 2 miles wide, do not harbor humpback whales. In contrast, the broad bank area of Silver and Navidad Banks contains the greatest concentration of humpback whales in the West Indies.

Similarly, in Hawaii Rice and Wolman (1979, unpubl. manuscr. submitted to IWC Scientific Committee) found by far the greatest number of whales on the Molokai-Lanai-Maui-Kahoolawe bank, a large shallow bank area generally surrounded by these four islands but also including Penguin Bank. They found the greatest concentration of whales, with 0.78 whale per square mile, on Penguin Bank, the largest single bank area in the main Hawaiian Islands. The second most important area was the Island of Hawaii, particularly the northwest coast where an expanded bank occurs between Upolu Point and Keahole Point. Other coastal areas surrounding the Island of Hawaii are bordered by a narrow shelf, with the exception of an expanded bank in Hilo Bay and at Ka Lae (South Point). Both these areas have yielded consistently high humpback whale counts (Figure 3).

In American Samoa a small number of humpback whales, including cows with calves, are sighted each year from July through October in the waters surrounding Tutuila Island. The bank surrounding Tutuila is especially broad off Cape Taputapu and Leone Bay. These areas yield the most sightings each year (J. Naughton, Southwest Region, National Marine Fisheries Service, Honolulu, pers. obs).

B. Leeward versus Windward

From December through March in Hawaiian waters, northeast trade winds are present about 55% to 65% of the time. These northeast trades result in generally consistent wind and wave action on windward coasts. Winds from the south and occasionally from the north account for the remainder of the wind and swell patterns (Herman 1979).

Rice and Wolman (1979, unpubl. manuscr. submitted to IWC Scientific Committee) found far more whales on the leeward side of the Hawaiian Islands than on the windward side. However, when calculated on the basis of whales per unit area, there was little difference between the two sides. They concluded that the greater abundance of whales on the leeward side appears to be due mainly to its larger areas of shallow water rather

than due to any marked preference by the whales for calmer waters. In fact, the single greatest density of whales was found on Penguin Bank (0.78 whale per square mile), an exposed bank area noted for its rough water.

Herman, Forestell, and Antinoja (1980) also noted that Penguin Bank is regularly exposed to strong, gusty trade winds, but is highly preferred humpback whale habitat. They found that windward areas of some Hawaiian Islands are not used much by whales, but this may reflect the limited extent of shallow water available and not the prevailing wind conditions. Herman (1979) concluded that there seemed to be no consistent relationship between wind or swell patterns and habitation by humpback whales.

In Australia, sheltered waters of the Great Barrier Reef between lat. 16°-21°S appear to be important breeding grounds for the East Australian humpback whale stock. However, there is evidence of humpback whales giving birth prior to reaching Great Barrier Reef waters (Paterson and Paterson 1984).

In the Bonin Islands, humpback whales including cows with new calves were found in the usually rough waters surrounding the islands. The islands are not high enough to create any significant lee, which is essentially nonexistent (Darling and Ford 1988).

C. Substrate

Very little work has been done on substrate characteristics of the banks where humpback whales are consistently found during the winter months. It is believed that humpback whales feed little, if at all, during winter (Matthews 1937; Chittleborough 1965; Dawbin 1966; Whitehead and Moore 1982). Therefore, the importance of substrate in attracting or supporting prey species does not appear to be a consideration.

Whitehead and Moore (1982) found the highest humpback whale song densities on Silver Bank in areas with virtually flat bottoms. Lowest song densities occurred where the bottom profile was rough, indicating coral growth. They concluded that there is evidence that singers select areas with smooth bottoms in the West Indies, thereby enhancing sound transmission.

No comparative analysis has been done for substrate preference in the Hawaiian Islands. However, bank areas with the highest concentration of whales (Penguin Bank, four-island area) are known for broad expanses of flat, sandy bottom as can be seen from bathymetric charts.

Surface Temperature

Whitehead and Moore (1982) found that humpback whales winter in the West Indies in waters of 24° to 28° C. They suspect that the warm waters are favorable for calving since the calves are born with a thin blubber layer. In the Southern Hemisphere Dawbin (1966) found that humpback whales winter in water temperatures of about 25° C.

In the Hawaiian Archipelago, sea-surface temperatures show relatively small seasonal and year-to-year changes, having a long-term average yearly range of 23.2°to 26.4° C (Seckel and Yong 1970). Surface temperatures during the winter in Hawaiian waters range between 23.2°and 24.2° C. These temperatures are slightly cooler than those found in other known humpback whale winter habitats.

The lack of sightings of humpback whales in the Northwestern Hawaiian Islands may be due to low sea-surface temperatures in the area. Huge bank areas occur there (i.e. Necker Island, Maro Reef, Gardner Pinnacles, Neva Shoal around Lisianski Island, French Frigate Shoals) and would seem to have

the desired characteristics; yet humpback whales are rarely sighted in these areas. Confirmed sightings have been made at Nihoa Island (A. Everson, Southwest Fisheries Center, National Marine Fisheries Service. Honolulu, pers. commun. and photos), and mothers and calves have been sighted at French Frigate Shoals (K. Kenyon, Seattle, WA., and J. Naughton, Southwest Region, National Marine Fisheries Service, Honolulu, pers. obs). However, aerial surveys specifically conducted to locate humpback whales in the northwestern Hawaiian Islands have found none (Herman, Forestell, and Antinoja 1980). The slightly cooler water in this more northerly segment of the Hawaiian Archipelago may preclude the use of these large banks as significant wintering areas by humpback whales.

Surface Salinity

In the Hawaiian Archipelago, maximum salinity occurs in November-February when the 35^{0}/oo salinity isopleth has moved south to lat. 17°-19°N (Uchida and Uchiyama 1986). Therefore, the surface salinity in the humpback whale wintering environment in Hawaiian waters is between 35^{0}/oo and 35.2^{0}/oo. Considering the low salinity found in much of the humpback whales' summer feeding grounds, it is improbable that salinity plays a major role in selection of wintering areas.

Surface Currents

Most areas of the Hawaiian Archipelago have a net surface current flow to the west. However, flows are modified by the shapes of the islands causing large eddies to form downstream. Close to shore, tides have a major influence on currents. In many coastal areas of Hawaii, a rotary semidiurnal tidal current is present, usually varying in direction and speed. The bank areas of importance to humpback whales are influenced mainly by tidal currents. The strength of these currents can vary from 3.0 to 32.5 cm/sec (Uchida and Uchiyama 1986).

Early studies in Hawaii suggested a general movement of humpback whales south to north through the main Hawaiian Islands in the winter (Baker and Herman 1981). Whales were thought to enter winter habitat at the Island of Hawaii and work through the main islands, departing later in the season at Oahu. The net current flow would support this hypothesis. However, Darling and Morowitz (1986) recently have shown that a few animals travel from Maui to Hawaii (north to south) in one season and suggest that the majority of the humpback whale population was present at least through the peak season (January - April). This would indicate some exceptions to the general trend and that surface currents may not play a major role in movement of humpback whales, at least within the Hawaiian Archipelago.

Turbidity

In considering the turbidity levels of glacial runoff waters and the generally nutrient rich conditions which comprise the humpback whales' summer feeding habitat, turbidity would not appear to have a negative environmental impact on whales in the wintering grounds. However, a number of observations have been made of humpback whales avoiding turbid coastal waters in Hawaii (Glockner-Ferrari and Ferrari 1985). During 1980, they reported that agricultural runoff from heavy winter storms created a dense mudline in nearshore waters, which the whales seemed to avoid. It was believed this may be a potentially important impact to the humpback whale population in Hawaii (Glockner-Ferrari and Ferrari 1985). Adult humpback whales have been observed swimming in clear water parallel to a meandering band of turbid, sediment-laden water from land runoff in the area of La'au Point, Molokai. They appeared to avoid swimming into the turbid water by changing direction

(J. Naughton, Southwest Region, National Marine Fisheries Service, Honolulu, pers. obs.). However, it is not known whether whales avoid these waters due to turbidity or to chemical pollutants from upland sources.

IMPACTS

Coastal Development

Known humpback whale habitat may be affected by harbor and boat ramp construction, nearshore resort development, alternative energy development, wastewater discharge and outfall construction, permanent vessel moorings, agricultural runoff, and recreational water sports. Water-dependent construction activities by themselves result in highly visible primary impacts such as blasting, dredging, and filling which may result in displacement, injury, and mortality. However, these adverse impacts can be reduced or eliminated through seasonal timing or construction design modifications, and the actual physical loss of habitat is small in comparison to the total available. It is the secondary and tertiary impacts associated with the initial habitat modification, such as increased vessel traffic associated with harbors, ramps, moorings and hotels, that may likely have irreversible consequences on the distribution and reproductive success of humpback whales.

Water quality degradation resulting from increased sewage effluent, surface runoff (agricultural, industrial, and residential), and the leaching of vessel hull anti-fouling compounds (e.g. tributyltin) may also adversely affect the distribution and physical well-being of humpback whales using nearshore waters. Untreated sewage dumped from vessel holding tanks and pumped from municipal outfalls during periods of overflow, such as storms and plant malfunctions, are sources of many infectious agents, viral, bacterial, and mycotic, to which cetaceans have shown a definite susceptibility (Dailey 1985; J.P. Schroeder 1988, Naval Oceans Systems Center, Kaneohe, HI, pers. commun.). The long-term effects of low concentrations of compounds such as tributyltin on larger vertebrates such as whales is not known.

Vessel Traffic

In Hawaii, humpback whales are subject to physical and acoustic disturbance by large numbers of recreational boaters as well as an increasing number of whale-watching vessels as they engage in water skiing, parasailing, jet skiing, high speed pleasure cruising, and whale watching. At present, commercial shipping and commercial fishing vessel traffic do not appear to pose a significant problem in Hawaiian waters because of the location of their activities, and/or their routes and behavior.

The Navy occasionally conducts vessel firing exercises off Kahoolawe Island. During a test to determine in-water source levels of naval gunfire and humpback whale vocalizations, it was found that ambient noise was dominated by humpback whale phonations (Friedl and Thompson 1981).

Normal whale behavior (the energetic and often acrobatic behavior associated with pod formation and disassociation and competitive activities, such as breaching and peduncle or fluke slapping), in some instances, is indistinguishable from reactions to vessels and makes the effects of vessel traffic in Hawaii difficult to evaluate. Recent studies, however, have provided some insight into this problem. Bauer and Herman (1986) found humpback whales off Maui to significantly alter behaviors in response to vessels within 1,000 m. Increases in dive times and some threat behaviors were observed. Short-term impacts of reduced fitness resulting from excessive energy expenditure

during the nonfeeding season were suggested. They postulated that these probable short-term impacts are linked to the potential for long-term negative effects such as displacement, reduced reproductive success, and reduced recruitment.

Glockner-Ferrari and Ferrari (1985, 1987) note a continuing decline in the percentage of cow-calf pairs sighted in nearshore waters off west Maui. In their early studies, they found 80.3% of the mothers and calves observed were within the 10-fathom (18 m) isobath. However, this percentage has steadily decreased, with a low in 1983 of 17.2% within the 10-fathom (18 m) isobath. In 1984 and 1985, the percentages again declined to 14.1 and 5.7%, respectively (Glockner-Ferrari and Ferrari 1987, Table 2). They attribute fewer whales being observed in nearshore waters to human activities, such as direct interactions between whales and vessels, and displacement by high-speed vessel operations. They also believe that habitat is being lost through the effects of pollution and report a decrease in water quality resulting from agricultural runoff from coastal development and sewage output.

Other recent studies also strongly indicate that humpback whales may be abandoning coastal habitat because of human activities. Herman, Forestell, and Antinoja (1980) noted a preference of humpback whales for subregions removed from areas of dense human habitation or activity. On the basis of aerial surveys, they observed an absence of whales within 5- to 6-km of Lahaina, Maui, and suggested that whales avoided the area because of human activities, primarily recreational boat traffic. Forestell (in press) also noted a lack of sightings in the Lahaina area relative to other areas off Maui. In addition, he found virtually no whales during aerial surveys within a 5- to 6-km radius around the new small boat ramp and protective breakwater at Keawakapu, Maui. He hypothesizes that whales, in fact, may be in these areas, but because of increased vessel traffic, they engage in behaviors that make them less obvious, such as remaining submerged for longer periods, or that more noticeable large pods of whales or cow-calf pairs may selectively avoid the area. Single animals, which typically remain underwater for longer periods, may be present in these areas yet be missed by aerial surveys.

Table 2. Percentage of mothers and calves sighted in nearshore waters off West Maui (from Glockner-Ferrari and Ferrari 1987).

Year	Ocean Hours of Observation (No.)	Mother-Calf Sightings (No.)	Mother-Calf Sets Within 0.4 km of Shore (No.)	Mother-Calf Sightings (%)
1977	174	39	25	64.1
1978	150	48	42	87.5
1979	134	47	37	78.7
1980	291	53	15	28.3
1981	228	52	17	32.7
1982	251	69	18	26.1
1983	233	63	11	17.5
1984	283	78	11	14.1
1985	282	88	5	5.7

Tinney (1988) lists and describes activities potentially affecting humpback whales in coastal waters of Hawaii. He states that these activities, occurring often enough, densely enough, or long enough in or near areas traditionally used by humpback whales may cause them to abandon or avoid the areas and possibly result in increased mortality and/or decreased reproduction.

Specific activities (from Tinney 1988), not in any particular order of importance, which potentially affect humpback whales include the following:

1. Swimming, snorkeling, and diving
2. Surfing
3. Wind and motorized surfing
4. Waterskiing
5. Kayaking
6. Recreational fishing
7. Commercial fishing
8. Sailing
9. Jetskiing
10. Addictor boating (rental mini-hydroplanes)
11. Parasailing
12. Whale watching
13. Scientific research
14. Marine transport
15. Water taxis
16. Surface warship operations
17. Submarine operations
18. Aircraft overflights
19. Marine construction

The effect of acoustic interference on "singing" and other related behaviors and its eventual impact on reproductive activities are not well known. "Singers," however, have been observed to stop singing when high speed or very loud vessels transited nearby (Bauer and Herman 1986).

At present, with the exception of the potential loss of summer foraging habitat, the continued loss and degradation of known preferred winter habitat in Hawaiian waters, particularly that of mothers and calves, probably constitutes one of the major threats to the recovery of the Hawaiian population of humpback whales. In order to better gage the prospects for and encourage recovery of this endangered species in Hawaii, habitat requirements and reproductive parameters for humpback whales in Hawaiian waters need to be more precisely defined. Further, a cost-effective and accurate means of determining population trends and a method of assessing the status of humpback whales in Hawaiian waters must be developed and initiated so that additional protective measures and recovery actions can be implemented should they be required.

LITERATURE CITED

Baker, C.S. 1985. The population structure and social organization of humpback whales (Megaptera novaeangliae) in the central and eastern North Pacific. Ph.D. Thesis, University of Hawaii, Honolulu.

Baker, C.S., and L.M. Herman. 1981. Migration and local movements of humpback whales through Hawaiian waters. Can. J. Zool. 59:460-469.

Baker, C.S., and L.M. Herman. 1984. Aggressive behavior between humpback whales (Megaptera novaeangliae) wintering in Hawaiian waters. Can. J. Zool. 62:1922-1937.

Baker, C.S., and L.M. Herman. 1985. Whales that go to extremes. Nat. Hist. Mag. 10:52-61.

Baker, C.S., and L.M. Herman. 1987. Alternative population estimates of humpback whales (Megaptera novaeangliae) in Hawaiian waters. Can. J. Zool. 65:2818-2821.

Baker, C.S., L.M. Herman, A. Perry, W.S. Lawton, J.M. Straley, and J.H. Straley. 1985. Population characteristics and migration of summer and late-season humpback whales (Megaptera novaeangliae) in Southeastern Alaska. Mar. Mam. Sci. 1(4):304-323.

Baker, C.S., L.M. Herman, A. Perry, W.S. Lawton, J.M. Straley, A.A. Wolman, G.D. Kaufman, H.E. Winn, J.D. Hall, J.M. Reinke, and J. Ostman. 1986. Migratory movement and population structure of humpback whales (Megaptera novaeangliae) in the central and eastern North Pacific. Mar. Ecol. Prog. Ser. 31:105-119.

Baker, C.S., L.M. Herman, and W.S. Stifel. 1981. Agonistic behavior in humpback whales: Evidence for male-male competition. Abstr. in Proceedings of the 4th Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, Dec. 14-18, 1981, p. 7.

Baker, C.S., A. Perry, and L.M. Herman. In press. Reproductive histories of female humpback whales in the North Pacific. Mar. Ecol. Prog. Ser.

Bauer, G.B., and L.M. Herman. 1986. Effects of vessel traffic on the behavior of humpback whales in Hawaii. Contract report to Nat. Mar. Fish. Serv., Southwest Region, Honolulu, HI. 151 pp.

Chittleborough, R.G. 1958. The breeding cycle of the female humpback whale, Megaptera nodosa (Bonnaterre). Aust. J. Mar. and Freshwater Res. 9:1-18.

Chittleborough, R.G. 1965. Dynamics of two populations of the humpback whale, Megaptera novaeangliae (Borowski). Aust. J. Mar. Freshwater Res. 16:33-128.

Clapham, P.J., and C.A. Mayo. 1987. The attainment of sexual maturity in

two female humpback whales. Mar. Mam. Sci. 3(3):279-283.

Dailey, M.D. 1985. Diseases of mammalia: Cetacea. Pages 805-847 in O. Kinne ed. Diseases of Marine Mammals. Vol. IV, Part 2. Biologische Anstalt Helgoland, Hamburg, FRG.

Darling, J.D. 1983. Migrations, abundance and behavior of Hawaiian humpback whales, Megaptera novaeangliae (Borowski). Ph.D. Thesis. University of California, Santa Cruz. 147 pp.

Darling, J.D., and D.J. McSweeney. 1985. Observations on the migrations of North Pacific humpback whales (Megaptera novaeangliae) Can. J. Zool. 63:308-314.

Darling, J.D., and H. Morowitz. 1986. Census of "Hawaiian" humpback whales (Megaptera novaeangliae) by individual identification. Can. J. Zool. 4:105-111.

Darling, J.D., and J.K.B. Ford. 1988. A study of the current status of humpback whales in Japan. Preliminary Rep. World Wildlife Fund Canada/ World Wildlife Fund Japan. 10 pp.

Dawbin, W.H. 1966. The seasonal migratory cycle of humpback whales. Pages 145-170. in K.S. Norris, ed. Whales, Dolphins, and Porpoises, 1977 edition. Univ. Calif. Press, Berkeley and Los Angeles.

Doi, T., T. Nemoto, and S. Ohsumi. 1967. Memorandum on results of Japanese stock assessment of fin whales in the North Pacific. Rep. Int. Whal. Comm. 17:111-115.

Dolphin, W.E. 1987. Ventilation and dive patterns of humpback whales, Megaptera novaeangliae, on their Alaskan feeding grounds. Can. J. Zool. 65:83-90.

Dolphin, W.E., and D.J. McSweeney. 1983. Incidental ingestion of Cassin's auklets by humpback whales. Auk. 100:214.

Forestell, P.H. In press. Assessment and verification of abundance estimates, seasonal trends, and population characteristics of the humpback whale in Hawaii. Marine Mammal Commission Contract Report No. MM2911014-6. 43 pp.

Friedl, W.A., and P.O. Thompson. 1981. Measuring acoustic noise around Kahoolawe Island. NOSC Tech. Rep. 732. Naval Oceans Systems Center, Hawaii Laboratory, Kailua, Hawaii. 15 pp.

Glockner-Ferrari, D.A., and M.J. Ferrari. 1985. Individual identification, behavior, reproduction, and distribution of humpback whales, Megaptera novaeangliae, in Hawaii. Marine Mammal Commission Contract Report No. MMC-83/06. Accession No. PB85-200772 NTIS, Springfield, VA.

Glockner-Ferrari, D.A., and M.J. Ferrari. 1987. Identification, reproduction, and distribution of humpback whales in Hawaiian waters, 1984 and 1985. Contract report to Natl. Mar. Fish. Serv., Natl. Mar. Mam. Lab., Seattle, WA. 32 pp.

Glockner, D.A., and S. Venus. 1983. Identification, growth rate, and Behavior of humpback whale (Megaptera novaeangliae) cows and calves in the waters off Maui, Hawaii, 1977-79. Pages 223-258 in R. Payne ed. Communication and Behavior of Whales. Westview, Boulder, CO.

Herman, L.M. 1979. Humpback whales in Hawaiian waters: A Study in historical ecology. Pac. Sci. Vol. 33, No. 1 .

Herman, L.M., and R.C. Antinoja. 1977. Humpback whales in the Hawaiian breeding waters: Population and pod characteristics. Sci. Rep. Whales Res. Inst. 29:59-85.

Herman, L.M., P.H. Forestell, and R.C. Antinoja. 1980. The 1976/77 migration of humpback whales into Hawaiian waters: Composite description. Marine Mammal Commission Contract Report No. MMC-77/19. Accession No. PB80-162332, NTIS, Springfield, VA.

Hudnall, J. 1978. Report on the general behavior of humpback whales near Hawaii, and the need for the creation of a whale park. Oceans 11(3):8-15.

Johnson, J.H., and A.A. Wolman. 1984. The humpback whale, Megaptera novaeangliae. Mar. Fish. Rev. 46(4):30-37.

Jurasz, C.M., and V. Jurasz. 1979. Feeding modes of the humpback whale, Megaptera novaeangliae, in Southeast Alaska. Sci. Rep. Whales Res. Inst. 31: 69-83.

Krieger, K., and B.L. Wing. 1984. Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, Southeast Alaska, Summer 1984. NOAA Tech. Memo., NMFS F/NWC/66. 60 pp.

Leatherwood, S., and R.R. Reeves. 1983. The Sierra Club Handbook of Whales and Dolphins, Sierra Club Books, San Francisco, CA. 302 pp.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982. Whales, Dolphins, and Porpoises of the Eastern North Pacific and Adjacent Arctic Waters - A Guide to Their Identification. U.S. Dep. Commer., NOAA Tech. Rep. NMFS Circ. 444, 245 pp.

Lien, J., and D. Aldrich. 1982. Damage to inshore fishing gear in Newfoundland and Labrador by whales and sharks during 1981. CAFSAC Marine Mammal Committee Meeting, St. Johns, Newfoundland, May 18-19, 1982. CAFSAC WP/82/04. NICOS Contribution No. 6, Newfoundland Inst. for Cold Ocean Sci., Mem. Univ. Newfoundland. 86 pp.

Lien, J., D. Jin Hai, L. Baraff, J. Harvey, and K. Chu. 1982. Whale entrapments in inshore fishing gear during 1982. Preliminary Report to Fisheries and Oceans Canada, Sept. 1983. NICOS Contribution No. 26. Newfoundland Inst. for Cold Ocean Sci., Mem. Univ. Newfoundland. 36 pp.

Lien, J., S. Stanforth, L. Fawcett, R. Vaughn, and D. Jin Hai. 1983. Whale and shark entrapments in inshore fishing gear during 1983, a preliminary Report to Fisheries and Oceans Canada, Sept. 23, 1983. NICOS Contribution. No. 43. Newfoundland Inst. for Cold Ocean Sci., Mem. Univ. Newfoundland. 36 pp.

Lien, J., H. Walter, and C. Harvey-Clark. 1985. Whale and shark entrapments in inshore fishing gear during 1985, a preliminary Report to Fisheries and Oceans Canada, 15 November 1985. NICOS Contribution No. 110. Newfoundland Inst. for Cold Ocean Sci., Mem. Univ. Newfoundland. 18 pp.

Matthews, L.H. 1937. The humpback whale, Megaptera nodosa. Discovery Rep. 17:7-92.

Mizroch, S.A. 1985. On the relationship between mortality rate and length in baleen whales. Rep. Int. Whal. Comm. 35:505-510.

Mobley, J.R., and L.M. Herman. 1981. Dynamic pod composition among humpback whales in Hawaiian waters. Abstr. in Proceedings of the 4th Biennial Conference on the Biology of Marine Mammals, San Francisco, CA, December 14-18, 1981. p. 81.

Mobley, J.R., and L.M. Herman. 1985. Transience of social affiliations among humpback whales (Megaptera novaeangliae) in the Hawaiian wintering ground. Can. J. Zool. 63:762-772.

Mobley, J.R., L.M. Herman, and A.S. Frankel. 1986. Sound playback experiments with humpback whales in the Hawaiian wintering grounds. Univ. Hawaii-Sea Grant Quart. 8(3):1-6.

Nishiwaki, M. 1959. Humpback whales in Ryukyuan waters. Sci. Rep. Whales Res. Inst., Tokyo. 14:49-87.

Nishiwaki, M. 1965. Whales and Pinnipeds. Univ. Tokyo Press, Tokyo, Japan. 439 pp.

Nishiwaki, M. 1972. General Biology-Megaptera novaeangliae. Pages 31-33 in S.H. Ridgway, ed. Mammals of the Sea-Biology and Medicine. Thomas, Springfield, IL. 812 pp.

Ohsumi, S. 1979. Interspecies relationships among some biological parameters in cetaceans and estimation of the natural mortality coefficient of the minke whale. Rep. Int. Whal. Comm. 29:397-406.

Paterson, R., and P. Paterson. 1984. A study of the past and present status of humpback whales in east Australian waters. Biol. Conserv. 29(4):321-343.

Payne, K., P. Tyack, and R. Payne. 1983. Progressive changes in the songs of humpback whales (Megaptera novaeangliae): A detailed analysis of two seasons in Hawaii. Pages 9-57 in R. Payne ed. Communication and Behavior of Whales. Westview, Boulder, CO.

Payne, R., and L.N. Guinee. 1983. Humpback whale (Megaptera novaeangliae) songs as an indicator of stocks. Pages 333-358 in R. Payne ed. Communication and Behavior of Whales. Westview, Boulder, CO.

Payne, R., and S. McVay. 1971. Songs of humpback whales. Science 173: 583-597.

Perkins, J.S., and P.C. Beamish. 1979. Net entanglements of baleen whales in the inshore fishery of Newfoundland. J. Fish. Res. Board Can. 36:521-528.

Perry, A., J.R. Mobley, C.S. Baker, and L.M. Herman. 1988. Humpback whales of the central and eastern North Pacific. Sea Grant Misc. Rep. UNHI-SEAGRANT-MR-88-02. Univ. Hawaii, Honolulu. 29 pp with photos.

Rice, D.W. 1978. The humpback whale in the North Pacific: Distribution, exploitation, and numbers. Pages 22-24 in K.S. Norris and R.R. Reeves, eds. Report on a workshop on problems related to humpback whales (Megaptera novaeangliae) in Hawaii. Marine Mammal Commission Contract Rep. No. MMC-77/03.

Seckel, G.R., and M.Y.Y. Yong. 1970. Harmonic functions for sea-surface temperatures and salinities, Koko Head, Oahu, 1956-69, and sea-surface temperatures, Christmas Island, 1954-69. Fish. Bull. 69(1):181-214.

Shallenberger, E.W. 1981. The status of Hawaiian cetaceans. Marine Mammal Commission Contract Report No. MM7AC028. Accession No. PB82-109398, NTIS, Springfield, VA. 79 pp.

Silber, G. In press. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (Megaptera novaeangliae). Can. J. Zool.

Siler, B. 1987. Sightseers warned to keep away from whales. Honolulu Star Bulletin. Jan. 15, 1987.

Stevens, T. 1988. Whale of a collision was first of its kind off Maui. Maui News. Apr. 15, 1988.

Straley, J.M. In press. Fall and winter occurrence of humpback whales, Megaptera novaeangliae, in

southeastern Alaska. In Rep. Int. Whal. Comm. Special Issue on Whale Identification.

Tanji, E. 1988. Humpback whale collision disables 24-foot, 2-ton boat. Honolulu Advertiser. April 16, 1988.

Tester, A.L. 1969. Cooperative shark research and control program, final report 1967-1969. Univ. Hawaii, Honolulu, 47 pp.

Thompson, T.J., H.E. Winn, and P.J. Perkins. 1979. Mysticete sounds. Pages 403-431 in H.E. Winn and B.L. Olla, eds. Behavior of Marine Mammals - Current Perspectives in Research. Vol. 3: Cetaceans. Plenum, New York and London.

Tinney, R.T. 1988. Review of information bearing upon the conservation and protection of humpback whales in Hawaii. Marine Mammal Commission Contract Report No. MM3309689-0. Accession No. PB88-195359, NTIS, Springfield, VA.

Tyack, P. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. Behav. Ecol. Sociobiol. 8:105-116.

Tyack, P. 1983. Differential responses of humpback whales, Megaptera novaeangliae, to playback of song or social sounds. Behav. Ecol. Sociobiol. 13:49-55.

Tyack, P., and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. Behavior 83:132-154.

Uchida, R.N., and J.H. Uchiyama, eds. 1986. Fishery Atlas of the Northwestern Hawaiian Islands. U.S. Dep. Commer., NOAA Tech. Rep. NMFS, 38. 142 pp.

Urban, J., and A. Aguayo. 1987. Spatial and seasonal distribution of the humpback whale, Megaptera novaeangliae, in the Mexican Pacific. Mar. Mam. Sci. 3(4):333-334.

Whitehead, H., and M.J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. Can. J. Zool. 60(9):2203-2211.

Winn, H.E., R.K. Edel, and A.G. Taruski. 1975. Population estimate of the humpback whale (Megaptera novaeangliae) in the West Indies by visual and acoustic techniques. J. Fish. Res. Board Can. 32:499-506.

Wolman, A.A., and C.M. Jurasz. 1977. Humpback whales in Hawaii: Vessel census, 1976. Mar. Fish. Rev. 39(7):1-5.

* U.S. GOVERNMENT PRINTING OFFICE: 731-084/60081

Appendix H

BACKGROUND TO THE PROPOSED HAWAII HUMPBACK WHALE NATIONAL MARINE SANCTUARY OF 1984

In the late 1970s some members of the scientific community began to wonder whether increasing human activities might be having adverse effects on humpback whales that inhabit Hawaiian waters. The Marine Mammal Commission, concerned about possible harassment of the whales owing to the frequent interaction of whales with human activities, sponsored a workshop to deal with this issue in 1977. In December of that year, James Hudnall, an independent whale researcher from California, submitted a formal proposal to the National Marine Sanctuary Program to establish a Hawaiian Humpback Whale National Marine Sanctuary. This action initiated the NOAA National Marine Sanctuary Program (NMSP) process in investigating and nominating the site.

At the same time in a local effort, the then Maui Mayor, Elmer Cravalho, designated December to May as "Whale Protection Months" and established a Maui County Whale Reserve in the waters lying landward of the 10-fathom isobath off Maui. Although National Marine Fisheries Service (NMFS) sent two national agents to monitor the situation and enforce existing regulations, no regulations accompanied the designation of the reserve and no administration or authority was established to administer or support the reserve.

In June 1978, NOAA's National Marine Fisheries Service (NMFS) held two public hearings in Hawaii to discuss the need to restrict human activities in principal humpback calving and assembly areas. A first step in exercising control of proposed detrimental activities was taken in January 1979, when NMFS published "Notice of Interpretation for Taking by Harassment" (FR 44[33]: 1114). This notice, the first, "Interpretation" of harassment under the MMPA and the ESA, listed guidelines that defined harassment, designated calving and breeding grounds where special guidelines were applicable, and gave NMFS springboard for enforcement and habitat protection. At the same time, efforts were made to educate the public through the publication and distribution of a pamphlet describing the humpback's behavior and endangered status, together with guidelines for approaching whales.

By May 1979, Federal marine sanctuary officials from NOAA's office of Ocean and Coastal Zone Management (OCZM) were reviewing Hawaiian whale protection proposals vis a vis comments solicited from various agency spokesmen, special interest groups, and private citizens. On October 31, a nomination for establishing a humpback whale national marine sanctuary in Hawaiian waters was included on the List of Recommended Areas (LAR) [44 FR 62552]. In December, NOAA convened a panel of experts, resource managers, local, State, and Federal officials in Hawaii to discuss the endangered Hawaiian humpback whale population, the need for additional research, education, possible regulatory measures, and management for assuring the long-term protection of the these whales in their wintering waters.

The "Hawaiian Humpback Whale Sanctuary Workshop Committee Report" described three management alternatives including: (1) status quo; (2) critical habitat designation as provided by the ESA; or (3) marine sanctuary designation under Title III of the Marine Protection, Research and Sanctuaries Act of 1972. Of the three alternatives, the committee concluded that designation of a marine sanctuary was the "most certain route to continuing protection of the humpback whale in Hawaiian waters." In October 1980, the National Marine Sanctuary Program held public information meetings on the islands of Maui and Oahu to present the findings and recommendations of the workshop and discuss the feasibility and desirability of proceeding forward with the sanctuary nomination.

In May 1981, NOAA held discussions with the Hawaii State Department of Planning and Economic Development (DPED), Department of Land and Natural Resources (DLNR), Department of Transportation (DOT), the Marine Affairs Coordinator's Office, and the Office of the Governor in order to discuss the outcome of the public meetings and draft an issue paper on the Hawaii marine sanctuary. On March 17, 1982, NOAA declared the proposed Hawaiian Humpback Whale National Marine Sanctuary an Active Candidate [47 FR 11544]. The "Proposed Hawai'i Humpback Whale National Marine Sanctuary Issue Paper" was released in April followed by a series of Hawaii public scoping meetings.

Governor George Ariyoshi appointed a neutral 15-member advisory group to assist the State in its evaluation of the proposal and to provide direct input into the development of the Environmental Impact Statement and Management Plan. In January, 1984, NOAA released the Draft Environmental Impact Statement and Draft Management Plan (OCRM 1983) and held public hearings during February. Although the proposed sanctuary met with strong opposition at the public hearings, NOAA apparently received enough written support to continue with the designation process.

In response to NOAA's continuation of the project, special interest groups rallied the Governor to withdraw State waters from sanctuary designation. In July 1984, in response to NOAA's request of the State's position regarding development of the Final Environmental Impact Statement and Management Plan, Governor Ariyoshi wrote to NOAA that "the state does intend to withdraw its waters" from the proposed sanctuary area should the proposal be passed by the U.S. Department of Commerce with Presidential approval. The Final Environmental Impact Statement and Management Plan were never sent to the Governor, and the Federal Office of Coastal Zone Management (OCZM) retained the option to renew the proposal at a later date or the possibility of establishing a sanctuary outside state waters.

Appendix I

WHALE EDUCATION PROGRAMS IN HAWAII

Bishop Museum Education Program
1525 Bernice Street
P.O. Box 19000A
Honolulu, HI 96817
Activities: *Thar She Blows* -- Short tour through the Bishop Museum's whaling exhibits and introduction to sperm whale skeleton (K-3).

Earthtrust
25 Kaneohe Bay Drive
Kailua, HI 96734
Activities: Earthtrust provides information on the status of pirate whaling. Efforts include: market analysis of whale products using DNA techniques, newsletter, adopt-a-whale and dolphin programs.

Department of Education
189 Lunalilio Home Road, 2nd Floor
Honolulu, HI. 96825-2099
Activities: Whale education is featured via science curriculum (K-6)

Department of Land and Natural Resources, Division of Aquatic Resources
1151 Punchbowl St.
Room 330
Honolulu, HI. 96813
Activities: Fishing education classes, in-school aquatic education and public outreach including community presentations, booklets, pamphlets, posters, videos and television commercials.

Hawaiian Islands Humpback Whale National Marine Sanctuary
726 S. Kihei Road or 300 Ala Moana Blvd. #5350
Kihei, HI 96753 Honolulu, HI 96850

Activities: Public outreach including community presentations, classroom lectures, and participation in whale-related community events.
Information available: Whale-watch brochure and other information materials.

Hawaii Whale Research Foundation
P.O. Box 1269
Lahaina, HI 96767
Activities: Research, education, and outreach programs and humpback whales and other marine mammals inhabiting the Hawaiian Islands.

Hawaii Wildlife Fund
P.O. Box 5361
Lahaina, HI 96761
Activities: Whale watch and coral reef naturalist programs. Conduct education programs for schools and the general community.

Kilauea Point National Wildlife Refuge
P.O. Box 87
Kilauea, Kauai, HI 96754
Activities: The Kilauea Point National Wildlife Refuge staff, in cooperation with Kilauea Point National History Association, operates a public information center at the refuge and develops publications on conservation issues which is available to schools and the general public. Publications: Kilauea Point Natural History Association. *Whale — What is a Whale?* (Hawaii Nature Focus — Nature Studies for Children — No 1.)

Lahaina Whaling Museum
865 Front Street
Lahaina, Hawaii 96761
Activities: Offers an array of memorabilia and whaling artifacts such as models of whaling ships, scrimshaws, ships' logs and harpoons.

National Marine Fisheries Service, Pacific Area Office
2570 Dole St.
Honolulu, HI 96822-2396
Information available: brochures, posters, scientific papers.

Ocean Mammal Institute
P.O. Box 14422
Reading, PA 19612
Activities: Volunteer research internship program affiliated with Albright College, PA.

Pacific Whale Foundation
101 N. Kihei Rd.
Kihei, Maui, HI 96753
Activities: The Pacific Whale Foundation is a non-profit research, education, and conservation organization whose purpose is to educate the public about marine animals and the ocean environment from a scientific perspective. Public Programs include, whales and Friends lecture series, whale day/earth day celebration, whalewatching, adopt-a-whale programs, outreach efforts in a Ocean van and at schools.

Sea Life Park Hawaii/ SLP Marine Research and Education
Makapuu Point
Waimanalo, HI 96795
Activities: Humpback Whale Awareness Month. Annual conservation program celebrating the humpback whale's annual return to Hawaii with lectures, marine artist youth competition and exhibit, and daily mini-lectures. Information available: whale brochures, whaling history museum, marine mammal exhibits, and presentations. Educational Department has special classroom activities on humpback whales.

Source: Hawaii Environmental Education Association. 1993. *Environmental Education Resource Guide*. Honolulu, Hawaii Environmental Education Association.

University of Hawaii
School of Ocean Earth Sciences Technology
Hawaii Institute of Marine Biology
P.O. Box 1346
Kaneohe, HI 96744
Activities: The Hawaii Institute of Marine Biology (HIMB) is a research institute of the University of Hawaii that fosters research and education in marine biological sciences. HIMB maintains a collection of books, scientific reports and dissertations.

Marine Options Program
University of Hawaii at Manoa
1000 Pope Road, Marine Sciences Bldg., Rm. 229

Honolulu, HI 96822
Activities: Student internship opportunities for graduate and undergraduate students.

Sea Grant Extension Service
University of Hawaii at Manoa
1000 Pope Road, MSB 226
Honolulu, HI 96822
Activities: The University of Hawaii Sea Grant Extension Service is a public outreach and information/technology program that supports research, education, and extension efforts that encourage sound management of the ocean's resources.

Kewalo Basin Marine Mammal Laboratory
University of Hawaii at Manoa
Kewalo Basin Marine Mammal Laboratory
1129 Ala Moana Blvd.
Honolulu, HI 96814
Activities: Earthwatch Program provides hands-on experience for persons interested in research on captive dolphins. Student internship programs and undergraduate directed studies program.

Waikiki Aquarium
Education Department
2777 Kalakaua Avenue
Honolulu, HI 96815
Information available: Educational department handles curriculum activities (K-6), incorporating the entire Hawaiian marine ecosystem. Brochures, handout materials, exhibits, and outreach programs are also available.

Whale Center of the Pacific
2435 Kaanapali Parkway, #H-16
Kaanapali, Lahaina, HI 96761
Activities: Educational outreach, museum exhibits, handouts and environmental workshop, including Whale Discovery Day.

Whales Alive
P.O. Box 2058
Kihei, HI. 96753
Activities: Research, educational outreach, handout materials, and slide images. Sponsors annual research conference: In Celebration of Whales.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix J

REFERENCES AND BIBLIOGRAPHY

Acevedo, A. and M. A. Smultea. 1995. First records of humpback whales including calves at Golfo Dulce and Isla Del Coco, Costa Rica, suggesting geographical overlap of Northern and Southern hemisphere populations. Mar. Mamm. Sci. 11 (4) 554-560.

Agegian, C.R., and F.T. Mackenzie. 1989. Calcareous organisms and sediment mineralogy on a mid-depth bank in the Hawaiian Archipelago. *Pac. Sci.* 43:56–66.

Altonn, H. 1991. Isle Scientists Investigate Dip in Seal Births. *Honolulu Star-Bulletin,* March 27, 1991.

Anders, G. 1987. *Native Hawaiian Fishing Rights in a Regulated Fishery: An Exploratory Analysis.* Pacific Islands Development Program, East-West Center, Honolulu.

Anonymous. 1987. *Recommendations for a five– year scientific investigation of the marine resources and environment of the main Hawaiian Islands.* Submitted to Department of Land and Natural Resources, State of Hawaii. Honolulu.

Antonius, A. 1985. Coral diseases in the Indo-Pacific: a first record. *Mar. Ecol.* 6:197–218.

Aotani and Associates. 1988. *Statewide Ocean Recreation Management Plan Final Report.* Report for the Hawaii Department of Transportation, Harbors Division.

Apple, R.A., and W.K. Kikuchi. 1975. *Ancient Hawaiian Shore Zone Fishponds: An Evaluation of Survivors for Historical Preservation.* Office of the State Director National Park Service, Honolulu.

Atkins, N., and S.L. Swartz. 1988. *Proceedings of the Workshop to Review and Reevaluate Whale Watching Programs and Management Needs, November 14–16, 1988, Monterey, California.* Center for Marine Conservation, Washington D.C. and NMFS Office of Protected Resources, Silver Spring, Maryland.

Bailey-Brock, J.H., and R.E. Brock. 1993. Aspects of the feeding, reproduction, and sensory biology of the Hawaiian anchialine shrimp, *Halocaridina rubra* Holthuis (Atyidae). *Pac. Sci.* 47:338–355.

Bailey-Brock, J.H. 1987. Section 3 Part II. Annelida. In: *Reef and Shore Fauna of Hawaii,* D.M. Devaney and L.G. Eldredge (eds.), pp. 213– 454. B.P. Bishop Museum Special Publ. 64(2 and 3). Honolulu.

Bak, R.P.M. 1978. Lethal and sublethal effects of dredging on coral reefs. *Mar. Poll. Bull.* 2:14–16.

Baker, C.S., and L.M. Herman. 1981. Migration and local movement of humpback whales (*Megaptera novaeangliae*) through Hawaiian waters. *Can. J. Zool.* 59:460–469.

Baker, C.S., L.M. Herman, B.G. Bays, and W.S. Stifel. 1982. *The Impact of Vessel Traffic on the Behavior of Humpback Whales in Southeast Alaska: 1981 Season.* Report to the National Marine Mammal Laboratory, Seattle, Washington.

Baker, C.S., L.M. Herman, B.G. Bays, and G.B. Bauer. 1983. *The Impact of Vessel Traffic on the Behavior or Humpback Whales in Southeast Alaska: 1982 Season.* Report to the National Marine Mammal Laboratory, Seattle, Washington.

Baker, C.S., and L.M. Herman. 1984. Aggressive behavior between humpback whales (*Megaptera novaeangliae*) wintering in Hawaiian waters. *Can. J. Zool.* 62:1922–1937.

Baker, C.S. 1985. *The Population Structure and Social Organization of Humpback Whales* (Megaptera novaeangliae) *in the Central and Eastern North Pacific.* Unpublished Ph.D. dissertation, University of Hawaii at Manoa, Honolulu, Hawaii.

Baker, C.S., L.M. Herman, A. Perry, W.S. Lawton, J.M. Straley, A.A. Wolman, G.D. Kaufman, H.E. Winn, J.D. Hall, J.M. Reinke, and J. Ostman. 1986. Migratory movement and population structure of humpback whales (*Megaptera novaeangliae*) in the central and eastern Pacific. *Mar. Ecol. Prog. Ser.* 31:105–119.

Baker, M.L. 1987. *Whales, Dolphins, and Porpoises of the World.* New York: Doubleday.

Baker, C.S. and L.M. Herman. 1987. Alternative population estimates of humpback whales (*Megaptera novaeangliae*) in Hawaiian waters.

Baker, C.S., A. Perry, and L.M. Herman. 1987. Reproductive histories of female humpback whales *Megaptera novaeangliae* in the North Pacific. *Mar. Ecol. Prog. Ser.* 41:103–114.

Baker, C.S., and L.M. Herman. 1989. *Behavioral Responses of Summering Humpback Whales to Vessel Traffic: Experimental and Opportunistic Observations.* Report to National Park Service; NP-NR-TRS-89-01.

Baker, C.S., S.R. Palumbi, R.H. Lambertsen, M.T. Weinrich, J. Calambokidis, and S.J. O'Brien. 1990. Influence of seasonal migration of geographic distribution of mitochondrial DNA haplotypes in humpback whales. *Nature* 344(6263):238-240.

Baker, C. S., D. A. Gilbert, M. T. Weinrich, R. Lambertsen, J. Calambokidis, B. McArdle, G. K. Chambers, and S. J. O'Brien. 1993. Population characteristics of DNA fingerprints in humpback whales (*Megaptera novaeangliae*). J. of Heredity 84: 281-290.

Baker, C. S., R. B. Slade, J. L. Bannister, R. B. Abernethy, M. T. Weinrich, J. Lien, J. Urban-R, P. Corkeron, J. Calambokidis, O. Vasquez, and S. R. Palumbi. 1994. Hierarchical structure of mitochondrial DNA gene flow among humpback whales, world-wide. Molecular Ecol. 3: 313 -327.

Balazs, G.H., R. Forsyth, and A. Kam. 1987. *Preliminary Assessment of Habitat Utilization by Hawaiian Green Turtles in Their Resident Foraging Pastures.* National Marine Fisheries Service Southwest Fisheries Center NOAA-TM-NMFS-SWFC-71.

Balazs, G.H. 1978. Terrestrial Critical Habitat for Sea Turtles Under United States Jurisdiction in the Pacific Region. *Elepaio.* V. 39 No. 4.

Balazs, G.H. 1980. *Synopsis of Biological Data on the Green Turtle in the Hawaiian Islands.* NOAA Technical Memorandum NMFS-SWFC-7. National Marine Fisheries Service Southwest Fisheries Center.

Balazs, G.H. 1984. *History of Sea Turtles at Polihua Beach, Northern Lanai.* National Marine Fisheries Service Southwest Fisheries Center Administrative Report H-84-15.

Banner, A.H., and D.M. Banner. Manuscript. Alpheidae. In: *Reef and Shore Fauna of Hawaii.* Section 5, Arthropoda, D.M. Devaney, and L.G. Eldredge (eds.), B.P. Bishop Museum Press, Honolulu.

Banner, A.H. 1974. Kaneohe Bay, Hawaii: urban pollution and a coral reef ecosystem. *Proceedings of the 2nd International Coral Reef Symposium* 2:685–702.

Beckwith, M., and K. Luomala. 1970. "Coming of the Gods." In *Hawaiian Mythology.* University of Hawaii Press, Honolulu pp. 1–11.

Bauer,G.B. 1986. *The Behavior of Humpback Whales in Hawaii and Modificatins of Behavior Induced by Human Interventions.* Unpublished doctoral dissertaion, University of Hawaii at Manoa, Honolulu, Hawaii.

Bauer, G., and L. Herman. 1986. *Effect of Vessel Traffic on the Behavior of Humpback Whales in Hawaii.* Report to Mantioanl Marine Fisheries Service, Honolulu, Hawaii.

Beach, D. W. and M. T. Weinrich. 1989. Watching the whales: Is an educational adventure for humans turning out to be another threat for endangered species? Oceanus 32(1): 84-88.

Bell, E. 1929. Log of the Chatham. *The Honolulu Mercury.* V. 1, pp. 55–69, 76–90.

Berger, A. 1981. *Hawaiian Birdlife.* Honolulu: University Press of Hawaii.

Blumentsock, D.I., and S. Price. 1967. *Climates of the States: Hawaii.* Government Printing Office, Washington, D.C.

Braham, H.W. 1984. The Statuts of endangered whales: an overview. Mar. Fish. Rev. 46(4):2-6.

Briggs, J.C. 1974. *Marine Zoogeography.* New York: McGraw Hill Book Co.

Brock, V.E. 1954. A preliminary report on a method of estimating reef fish populations. *J. Wildl. Manage.* 18:297–308.

Brock, V.E., and T.C. Chamberlain. 1968. A geological and ecological reconnaissance off western Oahu, Hawaii, principally by means of the research submarine "Asherah." *Pac. Sci.* 22:373–394.

Brock, R.E. 1979. An experimental study on the effects of grazing by parrotfishes and role of refuges in benthic community structure. *Mar. Biol.* 51:381–388.

Brock, R.E. 1986. *An inventory of the nearshore marine communities fronting the Kaanapali Airstrip, Maui.* Prepared for AECOS, Inc., Kailua, Hawaii.

Brock, R.E. 1987. *Biological reconnaissance of two sites in the Lahaina, Maui area proposed for possible marina development.* Prepared for AECOS, Inc., Kailua, Hawaii.

Brock, R.E., and J.E. Norris. 1987. *Biological assessment of sites proposed for habitat enhancement offshore of Honolulu Harbor, Oahu, Mala Wharf, Maui, and Kailua-Kona, Hawaii.* Prepared for AECOS, Inc., Kailua, Hawaii.

Brock, R.E. 1988a. *Assessment of the resident green sea turtle population in the vicinity of the Launiupoko State Park, West Maui, Hawaii.* Prepared for Sea Engineering, Inc., Makai Research Pier, Waimanalo, Hawaii.

Brock, R.E. 1988b. *Biological assessment of the Launiupoko, West Maui area for potential marina development.* Prepared for AECOS, Inc., Kailua, Hawaii.

Brock, R.E. 1989. *Predevelopment reconnaissance of the marine macrobiota and water quality conditions fronting the Lahaina Master Planned project, Lahaina, Maui.* Prepared for PBR Hawaii, Inc., Honolulu, Hawaii.

Brock, R.E., and J.E. Norris. 1989. An analysis of the efficacy of four artificial reef designs in tropical waters. *Bull. Mar. Sci.* 44:934–941.

Brock, R.E. 1990a. *Biological reconnaissance of the marine resources in the waters fronting West Beach, Oahu.* Final report. Prepared for OI Consultants, Inc., Waimanalo, Hawaii. EAC Rept. No. 90-09.

Brock, R.E. 1990b. Report addendum. *Predevelopment water quality conditions fronting the Lahaina Master Planned Project, Lahaina, Maui following heavy rainfall.* Prepared for PBR Hawaii, Inc., Honolulu, Hawaii.

Brock, R.E. 1992c. *A quantitative assessment of the marine communities and water quality along the Kaanapali, Maui coastline for the Puukolii and North Beach developments.* Prepared for AMFAC/JMB Hawaii, Inc., Lahaina, Hawaii. EAC Rept. No. 92-14.

Brock, R.E. 1992d. *A quantitative assessment of the marine communities and water quality in an area fronting the proposed Hulopoe-Manele Bay Golf Course development.* Monitoring program report. Prepared for Lanai Company, Inc., Honolulu, Hawaii. EAC Rept. No. 92-13.

Brock R.E. 1992e. *An analysis of benthic communities in the zone of mixing for Honolulu and Kahului electrical generation facilities.* Prepared for Hawaiian Electric Co., Honolulu, Hawaii. EAC Rept. No. 92-02.

Brock, R.E. 1992f. *A quantitative assessment of the marine communities and water quality along the Kaanapali, Maui coastline for the Puukolii and North Beach developments.* Prepared for Amfac/JMB Hawaii, Inc., Lahaina, Maui. EAC Rept. No. 92-14.

Brock, R.E. 1992a. *A quantitative assessment of the marine communities and water quality in an area fronting the proposed Hokukano development.* Prepared for The Anderson Companies, Scottsdale, Arizona. EAC Rept. No. 92-08.

Brock, R.E. 1992b. *Synopsis of change over a 57-month period of observation on benthic communities adjacent to the 40-inch coldwater pipe, Keahole Point, Hawaii.* Prepared for Natural Energy Laboratory of Hawaii Authority, Kailua-Kona, Hawaii. EAC Rept. No. 92-10.

Brock, R.E. 1993a. *Third semi-annual monitoring report on the status of the marine fish communities in the waters fronting the Mauna Lani Resort, South Kohala, Hawaii.* Prepared for Marine Research Consultants, Honolulu, Hawaii. EAC Rept No. 93-05.

Brock, R.E. 1993b. *Cooperative environmental monitoring program for the Natural Energy Laboratory Authority survey for anchialine and marine fish resources, May 1993 survey.* Prepared for Natural Energy Laboratory of Hawaii Authority, Kailua-Kona, Hawaii. EAC Rept. No. 93-06.

Brock, R.E. 1993c. *Marine communities and water quality in an area fronting the Hulopoe-Manele Bay Golf Course development – June 1993 field effort monitoring program report.* Prepared for Lanai Company, Inc., Honolulu, Hawaii. EAC Rept. No. 93-07.

Brock, R.E. 1993d. *A quantitative assessment of marine communities and water quality in an area fronting the proposed Hulopoe- Manele Bay Golf Course.* Prepared for Lanai Company, Inc., Honolulu, Hawaii. EAC Rept. No. 93-02.

Brock, R.E. 1993e. *An analysis of benthic communities in the zone of mixing for Honolulu and Kahului electrical generation facilities.* Prepared for Hawaiian Electric Co., Honolulu, Hawaii. EAC Rept. No. 93-01.

Brodie, P.F. 1975. Cetacean energetics, an overview of intraspecific size variation. *Ecology.* 56:152–161.

Brown, B.E., and L.S. Howard. 1985. Assessing the effects of "stress" on reef corals. *Adv. Mar. Biol.* 22:1– 63.

Brown,E., P. Forestell, and C. Jenner. 1980. *Biogeographical Factors Affection Humpback alves in Hawaii. 8th Biennial Conference on the Biology of Marine Mammals,* Abstracts.

Burnham, K.P., D.R. Anderson, and J.L. Laake. 1980. Estimation of density from line transect sampling of biological populations. *Wildl. Monog.* 72.

Calambokidis, J., G. Stiger, J. Evenson, and K. Flynn. 1996. Interchange and isolation of humpback whales off California and other North Pacific feeding grounds. Mar. Mamm. Sci.9 (1) 76-81.

Calambokidis, J., J. Straley, S. Mizroch, and S. Cerchio. In Press. An Overview of the movements of humpback whales in the North Pacific and evaluation of stock structure. In: Payne, M. P., B.A. Phillips, E. T. Nitta (Compliers). 1995. Draft report of the workshop to assess research and other needs and opportunities related to humpback whale management in the Hawaiian Islands, April 26-28, 1995, Kaanapali, Maui, Hawaii. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-OPR.

Chave, K.E., and J.N. Miller. 1977. *Baseline Studies and Evaluation of the Physical, Chemical, and Biological Characteristics of Nearshore Dredge Spoil Disposal, Pearl Harbor, Hawaii.* Part A: Baseline Studies, Investigation and Selection of a Suitable Dredge Spoil Site. Final Report. Prepared for the Pacific Division Naval Facilities Engineering Command, Honolulu, Hawaii. Environmental Center, University of Hawaii, Honolulu.

Cerchio, S., Gabriele, C. and Frankel, A. 1991. Inter-Island movements of humpback whales in the Hawaiian Islands: Three seasons off Kauai and Hawaii. Paper presented at the 9th Biennial Conference on the Biology of Marine Mammals, Chicago, IL, December 1991.

Cerchio, S. 1993. *Photographic Identification of Humpback Whales (Megaptera Novaeangliae) Off Kauai, Hawaii During Winter and Spring, 1993.* Draft Report to the ATOC Marine Mammal Program.

Cerchio, S., 1993. Geographic Variation and Cultural Evolution in Songs of Humpback Whales (*Megaptera Novaeangliae*) in the Eastern North Pacific. Master of Science Thesis. Moss Landing Marine Laboratory/San Jose State University.

Cerchio, S. 1994 (in prep). Estimates of humpback whale (*Megaptera Novaeangliae*) abundance off Kauai, Hawaii using mark-recapture techniques. Draft Report to NOAA, Sanctuaries and Reserves Division. 40 pp.

Cerchio, S. 1994 (in prep). Population Characteristics of Humpback Whale (*Megaptera novaengliae*) off the Hawaiian Island of Kauai, 1991 to 1993, as Inferred from Photographic Identification Data. Draft Report to NOAA, Sanctuaries and Reserves Division. October 1994. 33 pp.

Cerchio, S., C.M. Gabriele, and L.M. Herman. 1994 (in prep). Movements of humpback whales between Kauai and Hawaii, 1989-1991: Implications on population structure and abundance estimation in the Hawaiian Islands. Draft Report to NOAA, Sanctuaries and Reserves Division.

Cerchio, S. (In Press). An overview of humpback whale movements within Hawaiian waters. In: Payne, M. P., B. Phillips, E. T. Nitta (Compliers). 1995. Draft report of the workshop to assess research and other needs and opportunities related to humpback whale management in the Hawaiian Islands, April 26-28, 1995, Kaanapali, Maui, Hawaii. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-OPR.

Chesher, R. 1969. Destruction of Pacific corals by the seastar *Acanthaster planci. Science* 165:280– 283.

Chittleborough, R.G. 1954. Studies on the ovaries of the humpback whale, *Megaptera nodosa*, (Bonnaterre). *Aust. J. Mar. Freshwater Res.* 5:35–63.

Chittleborough, R.G. 1955. Aspects of reproduction in the male humpback whale, *Megaptera nodosa*, (Bonnaterre). *Aust. J. Mar. Freshwater Res.* 6:1–29.

Chittleborough, R.G. 1965. Dynamics of two populations of the humpback whale, *Megaptera nodosa* (Bonnaterre). *Aust. J. Mar. Freshwater Res.* 16:33–128.

Clapham, P. J. and C. A. Mayo. 1987. Reproduction and recruitment of individually identified humpback whales, *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979-1985. Can. J. Zool. 65(12): 2853-2863.

Clapham, P.J., and C.A. Mayo. 1988. Reproduction and recruitment of individually identified humpback whales *Megaptera novaeangliae*, observed in Massachusetts Bay, 1979–85. *Can. J. Zool.* 65:2853–2863.

Clapham, P. J. and D. K. Matilla. 1990. Humpback whale songs as indicators of migration routes. Mar. Mamm. Sci. 6: 151-154.

Clapham, P. J., P. J. Palsboll, D. K. Matilla, and O. Vasquez. 1992. Composition and dynamics of humpback whale competitive groups in the West Indies. Behaviour 122(3-4): 182-194.

Clapham, P. J., L. S. Baraff, C. A. Carlson, M. A. Christian, D. K. Matilla, C. A. Mayo, M. A. Murphy, and S. Pittman. 1993. Seasonal occurrence and annual return of humpback whales, *Megaptera novaeangliae*, in the southern Gulf of Maine. Can. J. Zool. 71(2): 440-443.

Clark, A.M., and F.W.E. Rowe. 1971. *Monograph of Shallow-Water Indo-West Pacific Echinoderms*. British Museum (Natural History), London.

Clark, Athline M. "Ocean Recreation" in Hawaii Ocean Resources Management Plan, Technical Supplement Hawaii Ocean and Marine Resources Council, January, 1991, pp 16-28

Clark, Athline M. "Hawaii's Experience in Managing the Expanding Use of Scenic Coastal Resources." Proceedings of the 1990 Congress on Coastal and Marine Tourism, 1990.

Clark, C.W., W. Ellison, and K. Beeman. 1986. Acoustic tracking of migrating bowhead whales. In: *IEEE Oceans '86 Conference Proceedings.*

Clay, G.S., S. Broder, R. Turner, D. Kitaoka, G. Rhodes, and D. Yamase, 1981. *Ocean Leasing for Hawaii.* Aquaculture Development Program, Department of Planning and Economic Development, Honolulu.

Cobb, J.N. 1908. Hawaiian Fishery Rights. *American Fishery Society Transactions*, V. 37. United States Bureau of Fisheries, Washington, D.C.

Cobb, J.N. 1902. Commercial Fisheries of the Hawaiian Islands. *U.S. Fisheries Commission* V. 12, p. 383–499.

Coles, S.L. 1984. Colonization of Hawaiian reef corals on new and denuded substrata in the vicinity of a Hawaiian power station. *Coral Reefs* 3:123–130.

Conant, S. 1993. Personal Communication with B. Mieremet.

Concerned Environmental and Scientific Community Coalition. 1994. Issues of Concern to the Scientific and Environmental Communities Regarding the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Connell, J. 1978. Diversity in tropical rain forests and coral reefs. *Science* 199:1302–1310.

Costa-Pierce, B. 1987. Aquaculture in ancient Hawaii. *Bioscience* 37(5):320–331.

Cox, D.C., and L.C. Gordon, Jr. 1970. *Estuarine pollution in the State of Hawaii.* Vol. 1. Statewide study. Tech. Rept. 31, Water Resources Research Center, University of Hawaii, Honolulu.

Dailey, M.D. 1985. Diseases of Mammalia: Cetacea. Pages 805-847. In O. Kinne (Ed.), *Diseases of Marine Mammals*. Vol. IV, Part 2. Biologische Anstalt Helgoland, Hamburg, Germany.

Darling, J.D., K.M. Gibson, and G.K. Silber. 1983. Observations on the abundance and behavior of humpback whales (*Megaptera novaeangliae*) off West Maui, Hawaii, 1977–79. In: *Communication and Behavior of Whales*, R.S. Payne (ed.), pp. 201–222, AAAS Selected Symposia Series, Boulder: Westview Press.

Darling, J.D. and Juarasz, C.M. 1983 Migratory destinations of North Pacific humpback whales (*Megaptera novaeangliae*). In Communication and behavior of whales. Edited by R. Payne. AAAS Selected Symposia Series, p. 359-368. Westview Press, Boulder, CO.

Darling, J.D. and D.J. McSweeney. 1984. Observations on the migrations of North Pacific humpback whales (*Megaptera novaeangliae*).

Darling, J. D. and H. Morowitz. 1986. Census of "Hawaiian" humpback whales (*Megaptera novaeangliae*) by individual identification. Can. J. Zool. 64.

Darling, J.D. 1991. *Humpback whales in Japanese waters: Ogasawara and Okinawa: Fluke identification catalog: 1987-90*, Tokyo: World Wildlife Fund.

Dawbin, W. H. 1966. The seasonal migratory cycle of humpback whales. In Whales, dolphins, and porpoises. Edited by K. S. Norris. University of California Press. Berkeley, CA. pp. 145-170.

Dawbin, W.H. 1977. The Seasonal Migratory Cycle of Humpback Whales. In *Whales Dolphins and Porpoises*. K.S. Norris (ed.), pp. 145–170 Berkeley: University of California Press.

Des Rochers, K. 1992. The impacts of an oil spill on Hawaii's natural environment: A general overview. In *Oil Spills at Sea: Potential Impacts on Hawaii*, R.T. Pfund (ed.). University of

DHM, Inc., 1990. *Hawaiian Fishpond Study: Islands of Hawaii, Maui, Lanai, and Kauai*. The Hawaii Coastal Zone Management Program, Honolulu.

Dizon, A. E., C. Lockyer, W. F. Perrin, D. P. DeMaster, and J. Sisson. 1992. Rethinking the stock concept: a phylogeographic approach. Conserv. Biol. 6: 24-36.

Dodge, R.E., R.C. Aller, and J. Thompson. 1974. Coral growth related to resuspension of bottom sediments. *Nature* 247:574–577.

Dodge, R.E., and J.R. Vaisnys. 1977. Coral populations and growth patterns: responses to sedimentation and turbidity associated with dredging. *J. Mar. Res.* 35:715–730.

Dohl, T. P. 1982. Marine mammal and seabird study - central and northern California. Annual Progress Report - Year II. Bureau of Land Management - Outer Continental Shelf. United States Department of Interior. Washington, DC. pp. 127-131.

Dollar, S.J., and R.W. Grigg. 1981. Impact of a kaolin clay spill on a coral reef in Hawaii. *Mar. Biol.* 65:269– 276.

Dollar, S.J. 1979. Ecological response to relaxation of sewage stress off Sand Island, Hawaii. University of Hawaii Water Resources Research Center, Tech. Rept. No. 124. Honolulu, Hawaii.

Dollar, S.J. 1982. Wave stress and coral community structure in Hawaii. *Coral Reefs* 1:71–81.

D'Vincent, C. G., R.M. Nilson, R. E. Hanna. 1985. Vocalization and coordinated feeding behavior of the humpback whale in southeastern Alaska. Sci. Rep. Whales Res. Inst. Tokyo 36: 41-47.

Edmondson, C.H. 1928. Ecology of a Hawaiian coral reef. *B.P. Bishop Museum Bull.* 45:1–64.

Ely, C.A. 1942. Shallow-water Asteriodea and Ophiuroidea of Hawaii. *B.P. Bishop Museum Bull.* 176:1– 63.

Emerson, N.B. 1893. The Long Voyages of the Ancient Hawaiians. *Papers of the Hawaiian Historical Society*. no. 5.

Emery, K., and D.C. Cox. 1956. Beachrock in the Hawaiian Islands. *Pac. Sci.* 10:382–402.

Emory, K.P. 1969. The Island of Lanai: A Survey of Native Culture. *Bernice P. Bishop Museum Bulletin*. No. 12.

Emory, K.P., and Y.H. Sinoto. 1965. Preliminary Report on the Archaeological Investigations in Polynesia: Fieldwork in the Society and Tuamotu Islands, French Polynesia, and American Samoa in 1962, 1963, 1964. *Transactions of the Bernice P. Bishop Museum*, pp. 99, 102, Honolulu.

Endean, R. 1976. Destruction and recovery of coral reef communities. In: *Biology and Geology of Coral Reefs*. O.A. Jones and R. Endean (eds.), pp. 215–255. Biology 2. New York: Academic Press.

Environmental Impact Study Corp. 1979. Environmental impact statement military use of Kahoolawe Training Area, Hawaiian Archipelago. Prepared for Department of the Navy. Environmental Impact Study Corporation, Honolulu, Hawaii.

Evans, C. 1992a. *Memorandum for J. Rousseau, Re: State of Hawaii Marine Resource Management Evaluation/Critique*. March 11, 1992.

Evans, C. 1992b. *Draft Information Paper: Conservation and Resource Management of the Humpback Whale in Hawaiian Waters*. Hawaii Liaison Office, Sanctuary and Reserves Division, Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. December 9, 1992.

Federal Register. 1987. *Endangered fish and wildlife: Approaching humpback whales in Hawaiian waters*. Vol. 52, No. 225, pp. 44,912– 44,915.

Fellows, D.P. 1966. Zonation and burrowing behavior of the ghost crabs *Ocypode ceratophthalmus* (Pallas) and *Ocypode laevis* Dana in Hawaii. M.S. Thesis, University of Hawaii, Honolulu.

Forbes, A.O. 1907. Ai Kanaka: A Legend of Molokai. In *Hawaiian Folk Tales*. Thos G.Thrum, compiler. pp. 186–192, Chicago: A.C. McClurg.

Forestell, P.H., L.M. Herman, and G.D. Kaufman. 1985. *Aerial Survey of Seasonal Trends and Population Characteristics of Humpback Whales in the Four-Island Region of Hawaii.* Abstract of the Sixth Biennial Conference on the Biology of Marine Mammals, Vancouver, British Columbia, November 22-26.

Forestell, P.H. 1989. *Assessment and verification of abundance estimates, seasonal trends, and population characteristics of humpback whales in Hawaii.* Final Report to the Marine Mammal Commission, Washington, D.C. NTIS Publication PB90-190273.

Forestell, P.H., E.K. Brown, L.M. Herman, and R.S. Schick. 1990. *Relative Frequency and Distribution of Humpback Whales and Boats Near Maui, Hawaii During the 1990 Winter Season.*

Forestell, P.H. and E.K. Brown. 1991. *Description of Humpback Whale Use of Maalaea Bay, Maui, Hawaii.* Final Report to the U.S. Army Engineer District, Honolulu. Contract No. DACW83-91-P-0601.

Forestell, P.H. and E.K. Brown. 1991. *Description of Humpback Whale Use of Maalaea Bay, Maui, Hawaii.* Final Report to the U.S. Army Engineer District, Honolulu. Contract No. DACW83-91-P-0601.

Forestell, P.H., and J.R. Mobley, Jr. 1991. *Humpback whale aerial survey throughout the major Hawaiian Islands during the 1991 season.* Draft Report to the National Marine Fisheries Service, December 1991.

Forestell, P.H. and E.K. Brown. 1992. *Aerial Survey of Humpback Whales (Megaptera novaeangliae) Near Kahoolawe, Hawaii: 1992.* Draft Final Report for the USDOC/NOAA Marine Sanctuaries Division. Contract 43ABNC201408.

Forestell, P.H., and E.K. Brown. 1992. *Cetacean abundance and distribution patterns off west Hawaii: Winter 1992.* Final report for the West Hawaii Coastal Monitoring Program, Hawaii.

Forestell, P.H., E.K. Brown, and R.S. Schick. 1993. *Observations of Humpback Whales and Other Cetaceans Off West Hawaii: Year Two (1993).* Final Report for the West Hawaii Coastal Monitoring Program.

Forestell, P.H. and G.D. Kaufman. 1993. Resource Managers and Field Researchers: Allies or Adversaries?

Forestell, P.H., J.R. Mobley, and R. Grotenfendt. 1996. Aerial Survey of Humpback Whales (Megaptera novaengliae) Near Kahoolawe, Hawaii: 1995. Draft Final Report to USDOC/NOAA Sanctuaries and Reserves Division. 13 pp.

Fornander, A. 1878. *An Account of the Polynesian Race.* London: Trubner.

Forsyth, N., J.R. Mobley, Jr., and G.B. Bauer. 1991. Depth preferences of 'Hawaiian' humpback whales. Poster presented at the *Ninth Biennial Conference on the Biology of Marine Mammals*, Chicago, December, 1991.

Frankel, A.S., C.W. Clark, L.M. Herman, C.M. Gabriele, M.A. Hoffhines, T.R. Freeman, and B.K. Patterson. 1989. Acoustic location and tracking of wintering humpback whales off south Kohala, Hawaii. *Eighth Biennial Conference on the Biology of Marine Mammals*, Abstracts, Pacific Grove, California.

Frankel, A.S., C.W. Clark, L.H. Herman, T.R. Freeman, C.M. Gabriele, and M.A. Hoffhines. 1991. The spacing function of humpback whale song. *Ninth Biennial Conference on the Biology of Marine Mammals*, Abstracts, Chicago, Illinois.

Frankel, A. S., C. W. Clark, L. M. Herman, and C. M. Gabriele. 1995. Spatial distribution, habitat utilization, and social interactions of humpback whales, *Megaptera novaeangliae*, off Hawaii determined using acoustic and visual techniques. Can. J. Zool. 73: 1134-1146.

Gabriele, Christine M. 1992. The Behavior and Residence Characteristics of Reproductive Classes of Humpback Whales (*Megaptera novaeangliae*) in the Hawaiian Islands.

Gendron, D. and J. R. Urban. 1993. Evidence of feeding by humpback whales (*Megaptera novaeangliae*) in the Baja California breeding ground, Mexico. Mar. Mamm. Sci. 9(1): 76-81.

Gilmartin, W.G. 1983. *Recovery Plan for the Hawaiian monk seal*, Monachus schauinslandi. National Marine Fisheries Service, Honolulu.

Gilmartain, W.G. 1994. Personal Communication with B. Mieremet. March 1994. National Marine Fisheries Service, Honolulu, HI.

Glockner, D.A., and S. Venus. 1983. Determining the sex of humpback whales (*Megaptera novaeangliae*) in their natural environment. In: *Communication and Behavior of Whales*, R.S. Payne (ed.), pp. 447–464, AAAS Selected Symposia Series, Boulder: Westview Press.

Glockner, D., and S. Venus. 1983. Identification, growth rate, and behavior of humpback whale, *Megaptera novaeangliae*, cows and calves in the waters off Maui, Hawaii, 1977–79. In R. Payne (ed.), *Communication and Behavior of Whales*. AAAS Symposia Series, Boulder: Westview Press.

Glockner-Ferrari, D.A., and M.J. Ferrari. 1984. Reproduction in humpback whales (Megaptera novaeangliae), in Hawaiian waters. In: *Reproduction in Whales, Dolphins, and Porpoises*. W.P. Perrin, G.P. Donovan, and D.P. DeMasters (eds.), pp. 237–242. Report to the International Whaling Commission, Special Issue 6.

Glockner-Ferrari, D.A., and M.J. Ferrari. 1985. Individual identification, behavior, reproduction, and distribution of humpback whales (Megaptera novaeangliae) in Hawaii. Marine Mammal Commission Contract Report No. MMC-83/06. Accession No. PB85-200772 NTIS, Springfield, VA.

Glockner-Ferrari, D.A., and M.J. Ferrari. 1987. *Identification, Reproduction, and Distribution of Humpback Whales in Hawaiian Waters, 1984–85.* Report to the National Marine Mammal Laboratory, Seattle, Washington.

Glockner-Ferrari, D. A. and M. J. Ferrari. 1990. Reproduction in the humpback whale (*Megaptera novaeangliae*) in Hawaiian waters, 1975-1988: The life history, reproductive rates and behavior of known individuals identified through surface and underwater photography. Rep. Int. Whale. Comm. (Spec. Issue) 12: 161-169.

Glynn, P.W. 1985. Corallivore population sizes and feeding effects following El Nino (1982–83) associated coral morality in Panama. In: *Proceedings of the 5th International Coral Reef Symposium* 4:183–187.

Gosline, W.A., and V.E. Brock. 1960. *Handbook of Hawaiian fishes.* Honolulu: University of Hawaii Press.

Gosline, W.A. 1965. Vertical zonation of inshore fishes in the upper water layers of the Hawaiian Islands. *Ecology* 46:823–831.

Gosline, W.A. 1955. The inshore fish fauna of Johnston Island, a Central Pacific atoll. *Pac. Sci.* 9:442–480.

Green, Marsha L. 1990. The Impact of Parasail Boats on the Hawaiian Humpback Whale (Megaptera novaeangliae). Paper Prepared for Marine Mammal Commission Hearings, March 1990.

Green, Marsha L. and Ronald G. Green. 1990. Short-term impact of Vessel Traffic on the Hawaiian Humpback Whale (Megaptera novaeangliae).

Grigg, R.W., and S.J. Dollar. 1990. Natural and anthropogenic disturbance on coral reefs. In: *Coral Reefs*, Z. Dubinsky (ed.), pp. 439–452. Amsterdam: Elsevier Science Publications B.V.

Grigg, R.W., and J.E. Maragos. 1974. Recolonization of hermatypic corals on submerged lava flows in Hawaii. *Ecology* 55:387–395.

Grigg, R.W. 1982. Darwin Point: a threshold for atoll formation. *Coral Reefs* 1:29–34.

Hain, J. H. W., S. L. Ellis, R. D. Kenney, P. J. Clapham, B. K. Gray, M. T. Weinrich, and I. B. Babb. 1995. Apparent bottom feeding of humpback whales on Stellwagen Bank. Mar. Mamm. Sci. 11(4): 464-479.

Hamnett, Michael P. "Fisheries" in Hawaii Oceans Management Plan, Technical Supplement Hawaii Ocean and Marine Resources Council, January, 1991, pp 38-48.

Harrigan, J. 1993. Personal Communication with B. Mieremet, B. Phillips and J. Sessing. Department of Health. Honolulu, HI.

Harrison, C.S. 1985. A Marine Sanctuary in the Northwestern Hawaiian Islands: An idea whose time has come. Natural Resources Journal 25:317-47.

Hawaii Audubon Society. 1989. *Hawaii's Birds.* Fourth Edition. Honolulu: Hawaii Audubon Society.

Hawaii Department of Business, Economic Development & Tourism (DEBDT). 1990. *The State of Hawaii Data Book: A Statistical Abstract.* Honolulu.

Hawaii State Department of Business, Economic Development & Tourism. 1992. *The State of Hawaii data book 1992: A statistical abstract.* Honolulu, Hawaii.

Hawaii Department of Business, Economic Development & Tourism. 1993. *Hawaii State Data Book 1992.* Department of Business, Economic Development & Tourism.

Hawaii Department of Health (DOH). 1989. *Nonpoint Source Pollution Assessment Report.*

Hawaii Department of Health (DOH). 1990. Water Quality Management Plan for the City and County of Honolulu. Report prepared by the Dept. of Public Works, City and County of Honolulu and the Hawaii Dept. of Health.

Hawaii Department of Health (DOH). 1993. Water Quality Management Plan for the County of Hawaii. Report prepared by the County of Hawaii and the Hawaii Dept. of Health. November 1993.

Hawaii Department of Health (DOH). 1993. Water Quality Management Plan for the County of Maui. Report prepared by the County of Maui and the Hawaii Dept. of Health. November 1993.

Hawaii Department of Health (DOH). 1993. Water Quality Management Plan for the County of Kauai. Report prepared by the County of Kauai and the Hawaii Dept. of Health. November 1993.

Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR). 1989. *Statewide Fish Aggregating System: Molokai Midwater Buoy Locations*, December 1989.

Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR). 1991. *Statewide Fish Aggregating System, Lanai Midwater Buoy Locations.* July 1991.

Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR). 1991. *Statistics, 1991.*

Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR). 1992. *Statistics, 1992.*

Hawaii Department of Land and Natural Resources/Division of Aquatic Resources (DLNR/DAR). 1992. *Hawaii Fishing Regulations, September.*

Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR). 1992. *Statewide Fish Aggregating System: Island of Kauai.* October 1992.

Hawaii Department of Land and Natural Resources, Division of Aquatic Resources (DLNR/DAR). 1992. *Statewide Fish Aggregating System: Island of Maui, Molokai, Lanai, and Kahoolawe.* May 1992.

Hawaii Department of Land and Natural Resources (DLNR/DAR) , Aquatic Life and Wildlife Advisory Committee. 1993. *Notes from the meeting of October 14, 1993 at Kealakehe Elementary School, Kona, Hawaii.*

Hawaii Department of Land and Natural Resources (DLNR/DAR). 1993. "Commercial Marine Live Landed by Month, Area, and Gear: Fiscal Year 1992-93" Division of Aquatic Resources, personal communication

Hawaii Department of Land and Natural Resources, (DLNR/DAR) Division of Aquatic Resources. 1993. *Statistics 1.*

Hawaii Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DLNR/DOBOR). 1992. *Vessel Registration Data.* December 31, 1992.

Hawaii Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DLNR/DOBOR). 1993a. *Small Boat Facilities on the Island of Kauai.*

Hawaii Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DLNR/DOBOR). 1993b. *Small Boat Facilities on the Island of Maui.*

Hawaii Department of Land and Natural Resources, Division of Boating and Ocean Recreation (DLNR/DOBOR). 1993c. *Small Boat Facilities on the Island of Molokai and Lanai.*

Hawaii Department of Planning and Economic Development and U.S. Department of the Interior, Minerals Management Service. 1987. *Mining Development Scenario for Cobalt-Rich Manganese Crusts in the Exclusive Economic Zones of the Hawaiian Archipelago and Johnston Island.* January 1987.

Hawaii Department of Transportation (DOT) "Port Hawaii: Commercial Harbors System" Harbors Division, 1993

Hawaii Department of Transportation (DOT), Harbors Division, Boating Branch. 1993. *Statistics, 1991–92.*

Hawaii Department of Transportation (DOT), Harbors Division. 1991. *Report of Undocumented Vessel Registration.* December 31, 1991.

Hawaii Department of Transportation (DOT), Harbors Division, Boating Branch. 1993. *Small Craft Mooring Facilities Utilization Report (quarterly) 1991–92.*

Hawaiian Electric Co., Inc., and B.P. Bishop Museum. 1975. *A survey of the marine benthos in the vicinity of the Kahului Generating Station Maui, Hawaii.* Prepared for Hawaiian Electric Co.

Hawaii Environmental Education Association (HEEA). 1993. *Environmental Education Resource Guide.* State Department of Land and Natural Resources, Division of Forestry and Wildlife, Honolulu.

Hawaii Ocean and Marine Resources Council (HOMRC). 1991. *Hawaii Ocean Resources Management Plan,* Hawaii Department of Business, Economic Development & Tourism, Honolulu. 49 pp.

Hawaii Ocean and Marine Resources Council (HOMRC). 1991. *Hawaii Ocean Resources Management Plan, Technical Supplement.* Hawaii Department of Business, Economic Development & Tourism, Honolulu. 71 pp.

Hawaii Office of State Planning. 1990. Hawaii Coastal Zone Management Program. 65 pp. Honolulu, HI.

Hawaii Office of State Planning. 1996. Hawaii's Coastal Nonpoint Pollution Control Program - Draft Management Plan, Volume 1. June 1996. Honolulu. 357 pp.

Hawaii State Constitution, Article XV, Section 1: Boundaries.

Hawaiian Sea Turtle Recovery Team. 1992. *Interim Recovery Plan for Hawaiian Sea Turtles.* Honolulu: National Marine Fisheries Service. Southwest Fisheries Science Center Administrative Report H-92-01.

Hawaii State Emergency Response Commission. 1992. Oil and Hazardous Substances Emergency Response Plan. Supplement to State of Hawaii Plan for Emergency Preparedness, Volume III. 34 pp.

Health, County of Maui. Tetra Tech, Inc., Lafayette, California.

Helweg, D.A., A.S. Frankel, J.R. Mobley, Jr., and L.M. Herman. 1993. Why humpback whales sing: Current understanding. In: *Sensory Abilities of Aquatic Mammals.* J.A. Thomas, R.A. Kastelein, and A. Supin (eds.), New York: Plenum Press.

Herman, L. and R. Antinoja. 1977. "Humpback whales in the Hawaiian breeding waters: Population and pod characteristics," *Sci. Rep. Whales Res. Inst.* 29:59–85.

Herman, L. P. 1979. Humpback Whales in Hawaiian Waters: a study in historical ecology. *Pacific Science* 33:1-15.

Herman, L., P. Forestell, and R. Antinoja. 1980. *The 1976/1977 Migration of Humpback Whales into Hawaiian Waters: Composite Description.* U.S. Department of Commerce, N.T.I.S. PB 80-162332.

Herman, L.M., P.H. Forestell, and R.C. Antinoja. 1980. *The 1976/77 migration of humpback whales into Hawaiian waters: Composite description.* Marine Mammal Commission, Washington, D.C., Report MMC– 77/19.

Herman, L. M. 1979. Humpback whales in Hawaiian waters: A study in historical ecology. *Pac. Sci.* 33:1–15.
Herman, L.M., and W.N. Tavolga. 1980. The communication systems of cetaceans. In: *Cetacean Behavior: Mechanisms and Functions*, L.M. Herman (ed.), pp. 149–209. New York: John Wiley and Sons, Inc.
Herrington Sound, Bermuda: eutrophication of a confined, phosphorus-limited marine ecosystem. *Estuarine Coast. Shelf Sci.* 28:347–360.
Hiruki, L.M., and T.J. Ragen. 1992. *A Compilation of Historical Monk Seal*, Monachus schauinslandi, *Counts*. NOAA Technical Memorandum, NOAA-TM-NMFS-SWFSC-172.
Hobson, E.S. 1984. The structure of reef fish communities in the Hawaiian archipelago: interim status report. In: *Proceedings of the Second Symposium on Resource Investigations in the Northwestern Hawaiian Islands*, Vol. 1. R.W. Grigg, and K.Y. Tanoue (eds.), pp. 101–122, University of Hawaii, Honolulu. Sea Grant Misc. Rept. UNIHI-SEAGRANT-MR-84-01.
Hobson, E.S. 1974. Feeding relationships of teleostean fishes on coral reefs in Kona, Hawaii. *Fish. Bull.* 72:915–1031.
Holmes, T. 1993. *The Hawaiian Canoe*. 2d ed. Editors Limited, Honolulu.
Hommon, R. 1975. *Use and Control of the Hawaiian Inter-Island Channels Polynesian Hawaii: A.D. 1400-1794*. Office of the Governor, Honolulu.
Hopley, D. 1982. *The Geomorphology of the Great Barrier Reef*. New York: Wiley-Interscience.
Hudson, A.E. 1932. *The Archaeology of East Hawaii*. Manuscript in Bernice P. Bishop Museum, Honolulu.
Inalab, Inc. 1992. 305(b) Water Quality Report for the State of Hawaii. Prepared for the Department of Health. April 1992. 66 pp.
Iversen, R.T.B., T. Dye, and L.M. Paul. 1990. *Native Hawaiian Fishing Rights (Phase 1 – The Northwestern Hawaiian Islands; Phase 2 – Main Hawaiian Islands and the Northwestern Hawaiian Islands)*. Western Pacific Regional Fishery Management Council, Honolulu.
Johannes, R.E. 1975. Pollution and degradation of coral reef communities. In: *Tropical Marine Pollution*, E.J. Ferguson, and R.E. Johannes (eds.) pp.13–50. Amsterdam: Elsevier Scientific Publishing.
Johnson, C.S. 1966. Auditory thresholds of the bottlenosed porpoise (*Tursiops truncatus*, Montague). NOTS Technical Publication 4178.
Johnson, J. H. and A. A. Wolman. 1984. The humpback whale, *Megaptera novaeangliae*. Mar. Fis. Rev. 46(4): 30-37.
Jokiel, P.L., and S.L. Coles. 1974. Effects of heated effluent on hermatypic corals at Kahe Point, Oahu. *Pac. Sci.* 28:1–18.
Jurasz, C. M. and V. P Jurasz. 1979. Feeding modes of the humpback whale, *Megaptera novaeangliae*, in southeast Alaska. Sci. Rep. Whales Res. Inst. 31: 69-83.
KRP Information Services. 1993. Water Quality Management Plan for the County of Maui. Prepared for the Hawaiian State Department of Health and County of Maui.
Kahaulelio, A. D. 1902. *Fishing Lore. Nupepa Kuokoa*. Bernice P. Bishop Museum Library.
Kahoolawe Island Conveyance Commission (KICC). 1993. Kaho`olawe Island: Restoring a cultural treasure. Final Report of the Kahoolawe Island Conveyance Commission to the Congress of the United States. 158 pp.
Kameeleihiwa, L. 1992. *Native Land and Foreign Desires: Pehea La E Pono Ai?* Bernice P. Bishop Museum Press, Honolulu.
Kassman, Ken "Aquaculture" in Hawaii Oceans Management Plan, Technical Supplement Hawaii Ocean and Marine Resources Council, January, 1991, pp 84-92
Katona, S. K. and H. P. Whitehead. 1981. Identifying humpback whales using their natural markings. Polar Record 20: 439-444.
Katona, S. K. and J. A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (*Megaptera novaeangliae*) in the western North Atlantic. Report of the International Whaling Commission (Special Issue 12): 295-305.
Kaufman, G., M. A. Smultea, and P. Forestell. 1987. Use of lateral body pigmentation patterns for photo Id in east Australian (Area V) humpback whales. Cetus 7 (1): 5-13.
Kawaharada, D. (ed.). 1992. *Hawaiian Fishing Legends*. Kalamaku Press, Honolulu.
Kay, E.A. 1977. Introduction to the revised edition. In: *Reef and Shore Fauna of Hawaii*, D.M. Devaney, and L.G. Eldredge (eds.), pp. 4–11. B.P. Bishop Museum Special Publication 64(1), Honolulu.
Kay, E.A. 1967. The composition and relationships of marine molluscan fauna of the Hawaiian Islands. *Venus* 25:94–104.
Kay, E.A. 1979. Hawaiian marine shells. In: *Reef and shore fauna of Hawaii.*, D.M. Devaney, and L.G. Eldredge (eds.), Section 4: Mollusca. Honolulu: B.P. Bishop Museum Press.
Kellogg, R. 1929. What is known about the migrations of some of the whalebone whales. In: *Annual Reports of the Smithsonian Institute for 1928*, pp. 467–494.

Ketten, D.R., J. Lien and S.Todd. 1993. Blast Injury in humpback whale ears: Evidence and implications. Invited paper, 126th meeting, Acoustical Society of America.

Khil, J. 1978. *Evolution of Sea Fishery Rights and Regulation in Hawaii and Their Implications for Conservation.* Preliminary Draft, Honolulu.

Kikuchi, W.K. 1976. Prehistoric Hawaiian Fishponds. *Science.* 193:295–299.

Kikuchi, W.K. 1973. *Hawaiian Aquacultural Systems.* PhD Dissertation. University of Arizona.

Kirch, P.V. 1985. *Feathered Gods and Fishhooks.* Honolulu: University of Hawaii Press.

Kirch, P.V. 1982. The ecology of marine exploitation in prehistoric Hawaii. *Hum. Ecol.* 10(4):455–476.

Knutsen, D., R. Buddemeier, and S.V. Smith. 1972. Coral chronometers: seasonal growth bands in reef corals. *Science* 177:270–272.

Kosaki, R. 1954. *Konohiki Fishing Rights.* Legislative Reference Bureau, University of Hawaii.

Krieger, K. J. and B. L. Wing. 1984. Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, summer 1983. NOAA Tech. Memo. NMFS F/NWC-66. U.S. Natl. Mar. Fish. Serv., Auke Bay, AK. 60 p. NTIS PB85-183887.

Krieger, K. J. and B. L. Wing. 1986. Hydroacoustic monitoring of prey to determine humpback whale movements. NOAA Tech. Memo. NMFS F/NWC-98. U.S. Natl. Mar. Fish. Serv., Auke Bay, AK. 62 p. NTIS PB86-204054.

Lal, Padma Narsey and Athline M. Clark "Personal Recreation Boating Industry in Hawaii: Physical Characteristics and Economic Contribution" Sea Grant Marine Economics Report UNIHI-SEAGRANT-ME-91-01; Ocean Resources Branch, DBEDT Contribution No. 94

Lapointe, B.E., and J. O'Donnell. 1989. Nutrient-enhanced growth of *Cladophora prolifera* in

Leatherwood, S. 1975. Some observations of feeding behavior of bottlenosed dolphins (*Tursiops truncatus*) in the northern Gulf of Mexico and *Tursiops gilli* in Baja, California and Nayant, Mexico. *Mar. Fish. Res.* 37:10–16.

Leatherwood, S., D.K. Caldwell, and H.E. Winn. 1976. *Whales, Dolphins, and Porpoises of the Western North Atlantic.* NOAA, Seattle. NOAA Technical Report, NMFS Circ. 396.

Leatherwood, S., W.F. Perrin, R.L. Farvie, and J.C. LaGrange. 1973. *Observations of Shark Attacking Porpoises* (*Stenella* spp. and *Delphinis* cf. *D. delphis*). NUC/TN 908.

Leatherwood, S., W.E. Evans, and D.W. Rice. 1972. *The Whales, Dolphins, and Porpoises in the Eastern North Pacific: A Guide to Their Identification in the Water.* San Diego: NUC Special Publication.

Lewis, J.R. 1964. *The Ecology of Rocky Shores.* London: English Universities Press.

Littler, M.M. 1973. The population and community structure of Hawaiian fringing-reef crustose Corallinaceae (Rhodophyta, Cryptonemiales). *J. Exp. Mar. Biol.* 11:103–120.

LMR Fisheries Research, Inc. "Hawaii Fisheries Plan: 1990-1995" prepared for Division of Aquatic Resources, Department of Land and Natural Resources, 1992

Loya, Y. 1976. Recolonization of Red Sea coral affected by natural catastrophes and man-made perturbations. *Ecology* 57:278–289.

Macdonald, G.A., A.T. Abbott, and F.L. Peterson. 1983. *Volcanoes in the Sea*, second edition. Honolulu: University of Hawaii Press.

MacDonald, C.D. and E.Corbin. 1989. "Issues and Analysis: Managing Ocean Resources for Tourism Development in Hawaii" OCEANS '89 Proceedings, 1989.

MacDonald, C.D. and H.E. 1989. Deese "A Comprehensive Analysis and Overview of Hawaii's Ocean Industries" Coastal Zone '89 Proceedings, 1989.

Macdonald, G.A., A.T. Abbott, and F.L. Peterson. 1990. *Volcanoes in the Sea: The Geology of Hawaii.* Honolulu: University of Hawaii Press.

MacDonald, C. D. and M. Markrich. 1992. "Hawaii's Ocean Recreation Industry: Economic Growth (1981-1995) and Management Considerations" Marine Technology Society '92 Proceedings, 1992.

MacDonald, C. D. and Athline M. Clark. 1993. "Hawaii's Ocean Recreation Industry: A Model for Regional Development in China" First International Ocean Recreation Activity and Resort Development Symposium, 1993.

MacDonald, C.D. and H.E. Deese. 1994. The Economic Potential of Hawaii's Ocean Industries. *In* MTS '94 Proceedings, Sept. 7-9, 1994. Washington, D.C. pp. 332-329. Marine Technology Society, Washington, D.C.

MacDonald, C.C., H.E. Deese, E. Corbin, and A.M. Clark. 1995. New Projections for Hawaii's Ocean Industries: A Stratetic Orientation. *In*: Ocean's '95 Proceedings, October 9-12, 1995. San Diego, CA. IEEE and Marine Technology Society, Washington, D.C. 10 pp.

Maciolek, J.A. 1984. Exotic fishes in Hawaii and other islands of Oceania. In: *Distribution, Biology and Management of Exotic Fishes.*, W.R. Courtenay, Jr., and J.R. Stauffer, Jr. (eds.), pp. 131–161. Baltimore: Johns Hopkins University Press.

Madden, W.D., and C.L. Paulsen. 1977. *The Potential for Mullet and Milkfish Culture in Hawaiian Fishponds.* Oceanic Institute for the State of Hawaii Department of Planning and Economic Development.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1984. *Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Gray Whale Behavior. Phase II: January 1984 migration.* Report by Bolt, Beranek, and Newman, Inc. for U.S. Department of the Interior, Minerals Management Service. BBN Technical Report No. 5586.

Malme, C.I., P.R. Miles, P. Tyack, C.W. Clark, and J.E. Bird. 1985. *Investigation of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Feeding Humpback Whale Behavior.* Final report to U.S. Dept. of the Interior Minerals Management Service (NTIS Publication No. PB86-218385).

Malo, D. 1951. Hawaiian Antiquities (*Moolelo Hawaii*). Trans. Nathaniel B. Emerson. 2d ed. Honolulu: Bernice P. Bishop Museum Press, Honolulu.

Mamala Bay Study Commission. 1993. East Mamala Bay Wastewater Facilities Master Plan. Dec. 1993.

Maragos, J.E. 1972. *A Study of the Ecology of Hawaiian Reef Corals.* Ph.D. Dissertation, University of Hawaii, Honolulu.

Maragos, J.E., G. Baines, and P. Beveridge. 1973. Tropical cyclone Bebe creates a new land formation on Funafuti Atoll. *Science* 181:1161–1164.

Maragos, J.E. 1977. Order Scleractinia stony corals. In: *Reef and Shore Fauna of Hawaii.*, D.M. Devaney, and L.G. Eldredge (eds.), pp.158–241. B.P. Bishop Museum Special Publication 64(1). Honolulu.

Marine Mammal Commission. 1992. Annual Report to Congress. Washingtion, D.C. 226 pp.

Marine Mammal Commission. 1993. Annual Report to Congress. Washington, DC.

Marine Mammal Commission. 1994. Annual Report to Congress. Washington, DC.

Marine Mammal Commission. 1995. Annual Report to Congress. Washington, DC.

Markrich, M. *Status reports on the 1990 economic characteristics of ocean recreation in Hawaii.* Planning document for the State of Hawaii Department of Business, Economic Development & Tourism. In preparation.

Marsalak, D.S. 1981b. Effects of sewage effluents on reef corals. *Abstract in Proceedings of the 4th International Coral Reef Symposium* 1:213.

Marsalak, D.S. 1981a. Impact of dredging on a subtropical reef community, southeast Florida, U.S.A. In: *Proceedings of the 4th International Coral Reef Symposium* 1:147–154.

Matilla, D. K. and P. J. Clapham. 1989. Humpback Whales (*Megaptera novaeangliae*) and other cetaceans on Virgin Bank and in the northern Leeward Islands, 1985 and 1986. Can. J. Zool. 67(9): 2201-2211.

Matilla, D.K., P. J. Clapham, S. K. Katona, and G. S. Stone. 1989. Humpback whales on Silver Bank, 1984: population composition and habitat use. Can. J. Zool. 67: 281-285.

Matsuoka, Jon, Davianna McGregor, Luciano Minerbi. 1994. *Governor's Moloka'i Subsistence Task Force Preliminary Report.* Report for the Moloka'i Subsistence Task Force and the Department of Business, Economic Development and Tourism.

Maui County Sanctuary Task Force. 1994. Issues of Concern to Maui County Related to the Congressionally Mandated Hawaiian Islands Humpback Whale National Marine Sanctuary.

Maybaum, H. L. 1990. Effects of a 3.3 kHz sonar system on humpback whales, *Megaptera novaeangliae*, in Hawaiian waters. Eos 71(2): 92.

Maybaum, H. L. 1993. Responses of humpback whales to sonar sounds. J. Acoust. Soc. Am. 94 (3, Pt. 2): 1848-1849.

McDermid, Karla J. 1990. Maalaea Boat Harbor Algal Survey.

Meller, N. 1985. *Indigenous Ocean Rights in Hawaii.* Honolulu: Sea Grant College Program. UNIHI-SEAGRANT-MP-86-01

Menard, H.W. 1964. *Marine Geology of the Pacific.* San Francisco: McGraw-Hill, Inc.

Meyer Resources, Inc. "A report on Resident Fishing in the Hawaiian Islands" developed for National Marine Fisheries Service, Southwest Fisheries Center Administrative Report H-87-8C, 1987

Miller, B.J. 1970. *Studies on the biology of Indo-Pacific Terebridae.* Ph.D. Dissertation, University of New Hampshire.

Mobley, J.M. Jr, and L.M. Herman. 1985. Transience of affiliations among humpback whales (*Megaptera novaeangliae*) on the Hawaiian wintering grounds. *Can. J. Zool.* 63:762–772.

Mobley, J.M., L.M. Herman, and A.S. Frankel. 1988. Responses of wintering humpback whales, *Megaptera novaeangliae*, to playback of recordings of winter and summer vocalizations and of synthetic sounds. *Behav. Ecol. Sociobiol.* 23:211–223.

Mobley J.R. Jr., and G.B. Bauer. 1991. Changes in distribution of humpback whales in Hawaiian wintering grounds: 1990 aerial survey results. Paper presented at the *Ninth Biennial Conference on the Biology of Marine Mammals*, Chicago, December 1991.

Mobley, J.R. Jr., P.H. Forestell, R. Grotefendt, T. Norris, M. Smultea, and A. Bowles. 1993. Aerial surveys of humpback whales in Hawaiian waters. In: *Tenth Biennial Conference on the Biology of Marine Mammals*, Abstracts, Galveston, Texas, November 5–9, 1993.

Mobley, J.R. Jr., P.H. Forestell, R. Grotefendt. 1994. Results of 1993 Aerial Surveys in Hawaiian Waters. 1993 ATOC Marine Mammal REsearch Program. Report to the Advance Research Projects Agency. 27 pp.

Mobley, J. R. Jr., P.H. Forestell, and R. A. Grotefendt. 1996. Preliminary Results of 1993 and 1995 aerial surveys of Hawaiian waters. Draft report to NOAA's Sanctuaries and Reserves Division.10 pp.

Moberly, R. Jr., L.D. Baver, Jr., and A. Morrison. 1965. Source and variation of Hawaiian littoral sand. *J. Sediment. Petrol.* 35:589–598.

Muffler, B. 1993. Personal Communication with B. Mieremet. Hawaii Undersea Research Laboratory, Waimanalo, Hawaii.

Muller, P.H. 1974. Sediment production and population biology of the benthic foraminifera *Amphistegina madagascariensis. Limnol. Ocean.* 19:802–809.

Murakami, A.T., and B. Freitas. 1987. Native Hawaiian Claims Concerning Ocean Resources. Presented at the *Hawaii Ocean Affairs Conference, East-West Center.* Native Hawaiian Legal Corporation.

Myers, R.F. 1989. *Micronesian Reef Fishes.* Guam: Coral Graphics, Barrigada.

National Marine Fisheries Service (NMFS). 1990. Biological Opinion of Endangered Species Act Section 7 Consultation Requested by the U.S. Army Corps of Engineers.

National Marine Fisheries Service. 1991. *Status of Pacific Oceanic Living Marine Resources of Interest to the USA* for 1991. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-165.

National Marine Fisheries Service (NMFS). 1991. *Final Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*).* Prepared by the Humpback Whale Recovery Team for NOAA, National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

Naughton, J.J. 1994. Personal Communication with B. Mieremet and B. Phillips. March 1994. National Marine Fisheries Service, Honolulu, HI.

Niemeyer, G., S.A. Cattell, G. Krasnick, D. Crear, R. Brock, and H. Snider. 1976. *Marine environmental reconnaissance study for proposed Lahaina Small Boat Harbor Maui, Hawaii.* Environmental Consultants, Inc., Kaneohe, Hawaii. Prepared for the U.S. Army Corps of Engineers, Honolulu.

Nishiwaki, M. 1966. Distribution and migration of the larger cetaceans in the North Pacific as shown by Japanese whaling results. In *Whales, Dolphins, and Porpoises*, K.S. Norris (ed.). Berkeley: University of California Press.

Nishiwaki, M. 1959. Humpback whales in Ryukuan waters. *Scientific Reports of the Whales Research Institute* 14:49–86.

Nitta, E. T. 1987. The marine mammal stranding network for Hawaii, an overview. In: *Marine Mammal Stranding Workshop*; J. E. Reynolds III, and Daniel K. Odell (eds.), December 3–5, 1987, Miami, Florida NOAA Publication.

Nitta, E.T., and J.J. Naughton. 1989. "Species Profiles: Life Histories and Environmental Requirements of Coastal Vertebrates and Invertebrates Pacific Ocean Region, Report 2, Humpback Whale," Technical Report EL 89-10. Prepared for Department of the Army, U.S. Army Corps of Engineers, Wash. D.C. 22 pp.

Nitta, E.T. 1994. Personal Communication with B. Mieremet and B. Phillips. March 1994. National Marine Fisheries Service, Honolulu, HI.

NOAA., Office of Ocean and Coastal Resources Management (NOAA/OCRM). 1983. Proposed *Hawaii Humpback Whale National Marine Sanctuary Draft Management Plan and Environmental Impact Statement.* Prepared by the Sanctuary Programs Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration, and State of Hawaii Department of Planning and Economic Development. 172 pp.

NOAA. 1991. Kahoolawe Island National Marine Sanctuary Feasibility Study. Prepared by the Sanctuary Programs Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration, and State of Hawaii Department of Planning and Economic Development, 1991. 42 pp.

NOAA., Office of Ocean and Coastal Resources Management (NOAA/OCRM). 1995. Hawaiian Islands Humpabck Whale National Marine Sanctuary Draft Environmental Impact Statement and Management Plan. Prepared by the Sanctuaries and Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration, and State of Hawaii Department of Planning and Economic Development. 264 pp.

Norris, K.S., and T.P. Dohl. 1980. The structure and function of cetacean schools. In *Cetacean Behavior: Mechanisms and Function.* L.M. Herman (ed.) pp. 211–262. New York: John Wiley and Sons.

Norris, K.S. and R.R. Reeves. 1978. *Report on a Workshop on Problems Related to Humpback Whales (Megaptera novaeangliae) in Hawaii.* Prepared for the Marine Mammal Commission.

Norris, K.S., B. Wursig, R.S. Wells, M. Wursig, S.M. Brownlee, C. Johnson, and J. Solow. 1985. *The Behavior of Hawaiian Spinner Dolphins,* Stenella longirostris. Final Report to NMFS. Southwest Fisheries Center, La Jolla, CA.

Ostman, J., and A.D. Driscoll. 1991. Observation of the social organization of Hawaiian spinner dolphins above and below the surface. In: *Ninth Biennial Conference on the Biology of Marine Mammals,* Abstracts. Chicago, Illinois, December 5–9, 1991.

Pacific Missile Range Facility, 1994. Briefing Documents, Kekaha, Hawaii.

Pastorek, R.A., and G.R. Bilyard. 1985. Effects of sewage pollution on coral-reef communities. *Mar. Ecol. Prog. Ser.* 21:175–189.

Patzert, W.C. 1970. *Eddies in Hawaiian Waters.* U.S. Geological Survey, U.S. Department of the Interior, Washington, D.C., Bulletin 8.

Patzert, W.C., K. Wyrtki, and H.J. Santamore. 1970. *Current Measurements in the Central North Pacific Ocean.* Hawaii Institute of Geophysics, HIG-70-31, Honolulu, Hawaii.

Payne, R.S., and S. McVay. 1971. Songs of humpback whales. *Science* 173:585–597.

Payne, R. 1978. Behavior and vocalizations of humpback whales (*Megaptera sp.*). In: K. S. Norris and R. R. Reeves (eds.), Report on a workshop on problems related to humpback whales (*Megaptera novaeangliae*) in Hawaii. MMC-77/03. Rep. from Sea Life Inc., Makapuu Pt., HI, for U.S. Mar. Mamm. Comm., Washington, DC. 90 p. NTIS PB-280794.

Payne, K. and R. S. Payne. 1985. Large-scale changes over 17 years in songs of humpback whales in Bermuda. Z. Tierpsychol. 68: 89-114.

Pearson, R. 1981. Recovery and recolonization of coral reefs. *Mar. Ecol. Prog. Ser.* 4:105–122.

Perry, A., J.R. Mobley, Jr., C.S. Baker, and L.M. Herman. 1988. *Humpback Whales of the Central and Eastern North Pacific: A Catalog of Individual Identification Photographs.* Sea Grant Miscellaneous Reports, UNIHI-SEAGRANT-MR-88–02.

Perry, A., C.S. Baker and L.M. Herman. 1990. Population characteristics of individually identified humpback whales in the central and eastern north Pacific: A Summary and Critique. *Reports of the International Whaling Commission, Special Issue* 12:307–317.

Perry, A., J.R. Mobley, C.S. Baker, and L.M. Herman. 1988. *Humpback Whales of the Central and Eastern North Pacific: A Catalog of Individual Identification Photographs.* University of Hawaii Sea Grant College Program, UNIHI-SEAGRANT-MR-88-02.

Pooley, Samuel G. 1993. "Hawaii's Marine Fisheries: Some History, Long-term Trends, and Recent Developments", Marine Fisheries Review 55(2).

Pukui, M.K. and S.H. Elbert (Eds.). 1986. Hawaiian Dictionary: Hawaiian-English, English-Hawaiian. Revised and Enlarged Edition. University of Hawaii Press, Honolulu. 572 pp.

Ragen, T.J. 1993. *Status of the Hawaiian Monk Seal in 1992.* National Marine Fisheries Service Southwest Fisheries Center Administrative Report H-93-05.

Ralston, C. 1984. Hawaii 1778-1854: Some aspects of Makaainana response to rapid cultural change. *J. Pac. Hist.* XIX:21–40.

Randall, J.E. 1987. Introductions of marine fishes to the Hawaiian Islands. *Bull. Mar. Sci.* 41:490–502.

Randall, J.E. 1980. New records of fishes from the Hawaiian Islands. *Pac. Sci.* 34:211–232.

Reeves, R. R. 1992. Whale responses to anthropogenic sounds: A literature review. Sci. & Res. Ser. 47. New Zealand Dep. Conserv., Wellington. 47 p.

Rice, D. W. 1974. Whales and whale research in the eastern North Pacific. In: Schevill, W. E., (ed.) The Whale Problem: a status report. Cambridge, Mass. Harvard University Press. pp. 170-195.

Rice, D.W. 1978. The humpback whale in the north Pacific: Distribution, exploitation, and numbers. In: *Report on a Workshop on Problems Related to Humpback Whales,* Megaptera novaeangliae *in Hawaii.* K.S. Norris, and R. Reeves (eds.) pp. 29–44. Report to the U.S. Marine Mammal Commission, Washington, D.C.

Rice, D.W., and A.A. Wolman. 1978. Humpback whale census in Hawaiian waters — February 1977. In: *Report on a Workshop on Problems Related to Humpback Whales (*Megaptera novaeangliae*) in Hawaii,* K.S. Norris, and R.R. Reeves (eds.). Final Report to the Marine Mammal Commission, Washington, D.C. NTIS No. PB 280 794.

Richardson, W.J., C.R. Greene, J.P. Hickie, and R.A. Davis. 1983. *Effects of offshore petroleum operations on cold water marine mammals: A literature review.* Report prepared by LGL Ecological Research Associates, Inc., Toronto, for the American Petroleum Institute, Washington, DC.

Richardson, W.J., M.A. Fraker, B. Wursig, and R.S. Wells. 1985. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: Reactions to industrial activities. *Biol. Conserv.* 32:195–230.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson. 1995. Marine mammals and noise. San Diego, CA. Academic Press. 576 p.

Risk, M.J. 1972. Fish diversity on a coral reef in the Virgin Islands. *Atoll Res. Bull.* 153:1–6.

Robertson, R. 1970. Review of the predators and parasites of stony corals with special reference to symbiotic prosobranch gastropods. *Pac. Sci.* 24:43.

Rogers, C.S. 1983. Sublethal and lethal effects of sediments applied to common Caribbean reef corals in the field. *Mar. Poll. Bull.* 14:378–382.

Rogers, C.S. 1985. Deterioration of Caribbean coral reefs: a monitoring/management program for reefs in Virgin Islands. *Fifth Congres Int. Recifs Coralliens*, Tahiti 2:330.

Russ, G.R., and A.C. Alcala. 1988. *A Direct Test of the Effects of Protective Management of a Tropical Marine Preserve*. South Pacific Commission, Inshore Fish. Res./BP.29.

Saila, S.B., and P.M. Roedel, eds. 1979. *Stock Assessment for Tropical Small-Scale Fisheries.* International Center for Marine Resource Development. University of Rhode Island, Kingston.

Salden, D. R. 1988. Humpback whale encounter rates offshore of Maui, Hawaii. J. Wildl. Manage. 52(2): 301-304.

Sale, P.F. 1977. Maintenance of high diversity in coral reef fish communities. *Am. Nat.* 111:337–359.

Schmitt, R.C. 1971. New estimates of the pre-censal population of Hawaii. *J. Polynesian Soc.* 80(2):238–240.

Schultz, Wendy L. "Energy" in Hawaii Oceans Management Plan, Technical Supplement Hawaii Ocean and Marine Resources Council, January, 1991, pp 93-106

Sewell, P.L. 1982. Urban ground water as a possible nutrient source for an estuarine benthic algal bloom. *Estuarine Coast. Shelf Sci.* 15:569–576.

Shallenberger, E.W. 1978. Activities possibly affecting the welfare of humpback whales. In Norris,K. and R. Reeves, eds. Report on a workshop on problems related to humpback whales (Megaptera novaeangliae) in Hawaii. Report to the Marine Mammal Commission, Contract No. MM7ac018. 90 pp.

Shallenberger, E.W. 1981. *The Status of Hawaiian Cetaceans.* Final Report to the Marine Mammal Commission, Washington, D.C. NTIS No. PB82 109398.

Shannon, S. 1991. "Marine Minerals" in Hawaii Oceans Management Plan, Technical Supplement Hawaii Ocean and Marine Resources Council, January, 1991, pp 107-117.

Sheppard, C. 1980. Coral fauna of Diego Garcia lagoon following harbor construction. *Mar. Poll. Bull.* 11:227–230.

Shinn, E. 1972. *Coral Reef Recovery in Florida and the Persian Gulf.* Environmental Conservation Dept., Shell Oil Co., Houston, Texas (cited in Grigg and Dollar 1990).

Shomura, R.S. 1987. *Hawaii's Marine Fishery Resources: Yesterday (1900) and Today (1986).*

Shomura, R.S., and T.S. Hida. 1965. Stomach contents of a dolphin caught in Hawaiian waters. *J. Mammal.* 46:500–501.

Silber, Gregory K. 1986. The relationship of social vocalizations to surface behavior and aggression in the Hawaiian humpback whale (*Megaptera novaeangliae).*

Small, R. J. and D. P. Demaster. 1995. Alaska Marine Mammal Stock Assessments 1995. U. S. Dep. of Commer. NOAA Tech. Memo. NMFS-AFSC-57.

Smith, M.K. In press. An ecological perspective on inshore fisheries in the main Hawaiian Islands. *Mar. Fish. Rev.*

Smith, M.K. An ecological perspective on inshore fisheries in the main Hawaiian Islands. *Mar. Fish. Rev.* (In press.)

Smith, S.V., W.J. Kimmerer, E.A. Laws, R.E. Brock, and T.W. Walsh. 1982. Kaneohe Bay sewage diversion experiment: perspectives on ecosystem responses to nutritional perturbation. *Pac. Sci.* 35:279–397.

Smultea, M. 1989. *Habitat Utilization Patterns of Humpback Whales off West Hawaii.* Report to the Marine Mammal Commission, Contract No. T6223925-9.

Smultea, Mari A. 1992. Habitat Utilization patterns of Humpback Whales (Megaptera Novaeangliae) Off the Island of Hawaii. Final Report to the U.S. Marine Mammal Commission.

Smultea, M.A. 1994. Segregation by humpback whale (*Megaptera novaeangliae*) cows with a calf in coastal habitat near the island of Hawaii.

Society for Marine Mammalogy. 1993. Movement of a Humpback Whale (*Megaptera novaeangliae*) Between Japan and Hawaii. *Marine Mammal Science* 9(1):84-89.

Soule, J.D., D.F. Soule, and H.W. Chaney. 1987. Phyla Entoprocta and Bryozoa (Ectoprocta). In: *Reef and Shore Fauna of Hawaii,* D.M. Devaney, and L.G. Eldredge (eds.), pp. 83–166, B.P. Bishop Museum Special Publ. 64 (2 and 3). Honolulu.

Southwest Fisheries Center, NMFS Honolulu, Laboratory Administrative Rept. H-87-21.
Stannard, D.E. 1989. *Before the Horror: The Population of Hawaii on the Eve of Western Contact.* Honolulu: The Social Science Research Institute, University of Hawaii.
State of Hawaii. 1990. *Hawaii Administrative Rules*, Section 19, Chapter 86, "Ocean Recreation Management Area Rules," (19 HAR 86).
Stearns, H.T. 1966. *Geology of the State of Hawaii.* Palo Alto: Pacific Books Publishers.
Stearns, H.T. 1969. *Road Guide to Points of Geologic Interest in the Hawaiian Islands*, second edition. Palo Alto: Pacific Books.
Stearns, H.T. 1969. *Geology of the Hawaiian Islands.* Hawaii Institute of Geophysics HIG-69-8.
Steiger, G. H., J. Calambokidis, R. Sears, K. C. Balcomb, and J. C. Cubbage. 1991. Movement of humpback whales between California and Costa Rica. Mar. Mamm. Sci. 7: 306-310.
Stoddart, D.R. 1963. Effects of Hurricane Hattie on the British Honduras reefs and cays, October 30-31, 1961. *Atoll Res. Bull.* 95:1–142.
Stoddart, D.R. 1969. Ecology and morphology of recent coral reefs. *Biol. Rev.* 44:433–498.
Stoddart, D.R. 1965. Re-survey of hurricane effects on the British Honduras reefs and cays. *Nature* 207:589–592.
Summers, C.C. 1964. Hawaiian Fishponds. *Bishop Museum Special Publication*, No. 52. Hawaii, Honolulu.
Surfing Education Association. 1971. *The 1971 Statewide Surfing Site Survey*, Report for the Hawaii Department of Planning and Economic Development, Vol. 1.
Sverdrup, H.U., M.W. Johnson, and R.H. Fleming. 1942. *The Oceans: Their Physics, Chemistry, and General Biology.* New Jersey: Prentice-Hall, Inc.
Swingle, W. M., S. G. Barco, and T. D. Pitchford. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Mar. Mamm. Sci. 9(3): 309-315.
Tabata, Raymond S. "Hawaii's Recreational Dive Industry and Use of Nearshore Dive Sites" Sea Grant Marine Economics Report UNIHI-SEAGRANT -ME-92-02; Ocean Resources Branch, DBEDT Contribution No. 98.
Tanaka, L. 1994. Personal Communication with B. Mieremet and B.Phillips. March 1994. Kailua-Kona, HI.
Tanji, E. 1992. Uninvited Kapalua Guest Won't Leave. *Honolulu Advertiser*, March 27, 1992.
Tanji, E. 1993. Hawaiian Monk Seal Turns Into a Maui Beach Bum. *Honolulu Advertiser*, February 6, 1993.
Tarnas, David A. & M. Carolyn Stewart. 1991. "Harbors" and "Waste Management" in Hawaii Oceans Management Plan, Technical Supplement Hawaii Ocean and Marine Resources Council, January, 1991, pp 29-37, and 73-83.
Taruski, A.G., Olney, C.E., and Winn, H.E. 1975. Chlorinated hydrocarbons in cetacean. J. Fish. Res. Bd. Canada. 32:2205-2209.
Tetra Tech, Inc. 1993. *Preliminary Assessment of Possible Anthropogenic Nutrient Sources in the Lahaina District of Maui.* Prepared for USEPA Region 9, Hawaii State Department of
Thrum, T.G. 1907. *Hawaiian Folk Tales: A Collection of Native Legends.* Chicago: A.C. McClurg and Co.
Timbol, A.S. 1972. *Trophic Ecology and Macrofauna of Kahana Estuary, Oahu.* Ph.D. Dissertation, University of Hawaii, Honolulu.
Tinker, S. W. 1988. Whales of the world. Honolulu, HI. Bess Press Inc.
Tinney, R.T. 1988. *Review of Information Bearing Upon the Conservation and Protection of Humpback Whales in Hawaii.* Marine Mammal Commission final report. Contract No. MM2209689-0.
Titcomb, M. 1972. *Native Use of Fish in Hawaii.* Honolulu: University of Hawaii Press.
Tomilin, A.G. 1967. Cetacea. In: *Mammals of the USSR and Adjacent Countries*, Vol 9. Israel Program for Scientific Translations, Jeruselum.
Townsend, R.T. 1991. *Conservation and Protection of Humpback Whales in Hawaii – An Update.* Final Report for the U.S. Marine Mammal Commission T-75132495. 58 pp.
Tyack, P. 1989. Let's have less public relations and more ecology. *Oceans.* 32:103–108.
Tyack, P., and H. Whitehead. 1983. Male competition in large groups of wintering humpback whales. *Behaviour* 83:132–154.
Tyack, P. 1981. Interactions between singing Hawaiian humpback whales and conspecifics nearby. *Behavioral Ecology and Sociobiology* 8:105–116.
Tyack, P. 1983. Differential response of humpback whales, *Megaptera novaeangliae*, to playback of song or social sounds. *Behav. Ecol. Sociobiol.* 13:49–55.
Umbgrove, J.H.F. 1930. The end of Sluiter's coral reef at Krakatoa. *Leidse Geologische Mededelingen* 3:261– 264.
University of Hawaii, Department of Geography. 1983. *Atlas of Hawaii.* 2d ed. University of Hawaii Press, Honolulu.
University of Hawaii Sea Grant College Program. UNIHI-SEAGRANT-CR-92-06.

University of Hawaii Sea Grant College Program (UHSG). 1985. *Humpback Whales in Hawaii: Guide for the Amateur Whale-Watcher.* University of Hawaii Sea Grant College Program, UNIHI-SEAGRANT-MB-86-01.

University of Hawaii Sea Grant College Program. 1994. A Site Characterization Study for the Hawaiian Islands Humpback Whale National Marine Sanctuary. Prepared for the National Oceanic and Atmospheric Administration. UNIHI-SEAGRANT-MR-94-06. 120 pp.

U.S. Army Corps of Engineers. 1983. *A Decade of Ecological Studies Following Construction of Honokohau Small Boat Harbor, Kona, Hawaii.* U.S. Army Engineer District, Honolulu, Hawaii.

U.S. Army Corps of Engineers. 1992. Draft Supplemental Environmental Impact Statement for Maalaea Harbor for Light-Draft Vessels Maui, Hawaii.

U.S. Army Corps of Engineers. 1994. Letter from Lieutenant Colonel Bruce Elliott to Janice Sessing and Dick Poirer. U.S. Army Engineer District, HonoluluU.S. Corps of Engineers. 1992. Determination of Federal Consistency: For Navigation Improvements for the Maalaea Small Boat Harbor, Honolulu.

U.S. Army Corps of Engineers. 1989. *Proposed Maintenance Dredging: Public Notice PODCO MD-90,* December 1, 1989.

U.S. Army Corps of Engineers.1991.*Waterborne Commerce of the U.S. Calendar Year 1989.* Part 4

U.S. Coast Guard, District 14. 1992. *Statistics, 1991.*

U.S. Coast Guard, District 14. 1993. Federal On-Scene Coordinator (FOSC) Honolulu Area Contingency Plan (ACP). Commander, Fourteenth Coast Guard District, Honolulu, HI.

U.S. Environmental Protection Agency. 1980. *Final Environmental Impact Statement for Hawaii Dredged Material Disposal Sites Designation.* Oil and Special Materials Control Division, Marine Protection, Washington, D.C.

U.S. Fish and Wildlife Service. 1992. *Endangered and Threatened Wildlife and Plants.* 50 CRF 17.11 and 17.12.

U.S. Fish and Wildlife Service. 1989. *Kilauea Point National Wildlife Refuge Public Use Management Plan Draft.* U.S. Fish and Wildlife Service, Honolulu.

U.S. National Marine Fisheries Service. 1991. *Status of Pacific Oceanic Living Marine Resources of Interest to the USA* for 1991. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-165.

U.S. National Park Service. 1993. Hawaiian and pacific Islands National Wildlfe Refuge Complex Summary.

U.S. National Park Service. 1993. Kauai National Wildlife Refuge Complex Summary.

Walsh, G.A. 1963. *An Ecological Study of the Heeia Mangrove Swamp.* Ph.D. Dissertation, University of Hawaii, Honolulu.

Watkins, W. A. 1986. Whale reactions to human activities in Cape Cod waters. Mar. Mamm. Sci. 2(4): 251-262.

Watkins, W. A. and W. E. Schevill. 1979. Aerial observation of feeding behavior in four baleen whales: *Eubalaena glacialis, Balaenoptera borealis, Megaptera novaeangliae, and Balaenoptera physalus.* J. Mammal 60: 155-163.

Weinrich, M. T., M. R. Schilling, and C. R. Belt. 1992. Evidence for acquisition of a novel feeding behavior: lobtail feeding in humpback whales, *Megaptera novaeangliae.* Animal Behavior 44: 1059-1072.

Wentworth, C.K. 1939. Marine bench-forming processes: II, solution benching. *J. Geomorphol.* 2:3–25.

Wentworth, C.K. 1938. Marine bench-forming processes: water-level weathering. *J. Geomorphol.* 1:6–32.

West Hawaii Coastal Monitoring Task Force. 1992. West Hawaii Coastal Monitoring Program: Protocol Guidelines. Available through the West Hawaii Sea Grant Office, Kona, Hawaii.

Western Pacific Regional Fishery Management Council (WPRFMC). 1993. *1992 Annual Report on Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region,* Honolulu.

Whitehead, H. and M. J. Moore. 1982. Distribution and movements of West Indian humpback whales in winter. Can. J. Zoology 60: 2233-2211.

Winn, H.E. 1977. Environmental correlates on the humpback whale on the tropical winter calving grounds. In: *Report on a Workshop on Problems Related to Humpback Whales (*Megaptera novaeangliae*) in Hawaii.* K.S. Norris and R.R. Reeves (eds.).

Winn, H.E., and L.K. Winn. 1978. The song of the humpback whale *Megaptera novaeangliae* in the West Indies. *Mar. Biol.* 47:97–114.

Winn, H.E. and N. Reichley. 1985. Humpback whale -- *Megaptera novaeangliae.* pp. 375 -382, In Ridgway, S.H. and Harrison, R. (eds.) Handbook of marine mammals. Vol 3: The Sirenians and Baleen Whales. London, Academic Press.

Witham, E. 1994. Personal Communication with B.Mieremet and B.Phillips. National Marine Fisheries Service. March 1994. Honolulu, HI.

Wolman, A.A., and C.M. Jurasz. 1977. Humpback whales in Hawaii: Vessel census, 1976. *Mar. Fish. Rev.* 39(7):1–5.

Wolman, A.A. 1978. Humpback whale. In: *Marine Mammals of Eastern North Pacific and Arctic Waters.* D. Haley (ed.), Seattle: Pacific Search Press.

Wursig, B., F. Cipriano, and M. Wursig. 1991. Dolphin movement patterns: Information from radio and theodolite tracking studies. In *Dolphin Societies: Discoveries and Puzzles*, K. Pryor, and K.S. Norris (eds.), pp.79–112. Berkeley: University of California Press.

Wyban, C.A. 1993. Report of the Governor's Task Force on Moloka'i Fishpond Restoration. Prepared for the State of Hawaii, Department of Business, Economic Development and Tourism, Moloka'i Office.

Wyrtki, K., V. Graefe, and W.M. Patzert. 1969. *Current Observations in the Hawaiian Archipelago.* University of Hawaii Institute of Geophysics HIG-69-15, Honolulu.

Wyrtki, K., J.B. Burks, R.C. Latham, and W.M. Patzert. 1967. *Oceanographic Observations During 1965-1967 in the Hawaiian Archipelago.* Hawaii Institute of Geophysics HIG-67-15, Honolulu.

Wyrtki, K. 1970. Flights *with Airborne Radiation Thermometers in Hawaiian Waters.* Hawaii Institute of Geophysics HIG-70-5, Honolulu.

Wyrtki, K. 1990. Sea level rise: The facts and the future. *Pac. Sci.* 44(1):1–16.

Yablokov, Alexey V. 1994. Validity of whale data. *Nature* 367:108.

Yonge, C.M. 1931. The biology of reef building corals. *Scientific Reports of the British Museum (Nat. Hist.),* I:353–391.

Zimmerman, E.C. 1948. *Insects of Hawaii. Vol. 1. Introduction.* Honolulu: University of Hawaii Press.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix K

DESIGNATION DOCUMENT AND IMPLEMENTING REGULATIONS

Section 304(a)(4) of the National Marine Sanctuaries Act (NMSA) requires that the terms of designation include the geographic area included within the Sanctuary; the characteristics of the area that give it conservation, recreational, ecological, historical, research, educational, or aesthetic value; and the types of activities that will be subject to regulation by the Secretary of Commerce to protect these characteristics. The terms of designation may be modified only by the procedures provided in section 304(a) of the NMSA. Thus, the terms of designation serve as a constitution for the Sanctuary. In the case of this Congressionally designated Sanctuary, some terms of designation (e.g., boundary) were contained in the Hawaiian Islands National Marine Sanctuary Act, subject to modification by the Secretary.

A. Designation Document for the Hawaiian Islands Humpback Whale National Marine Sanctuary

On November 4, 1992, President Bush signed into law the Hawaiian Islands National Marine Sanctuary Act (HINMSA or Act; Subtitle C of the Oceans Act of 1992, Pub. L. No. 102-587) which designated the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS or Sanctuary).

The purposes of the Sanctuary are to:

(1) protect humpback whales and their Sanctuary habitat;
(2) educate and interpret for the public the relationship of humpback whales to the Hawaiian Islands marine environment;
(3) manage human uses of the Sanctuary consistent with the designation and Title III of the Marine Protection, Research and Sanctuaries Act, as amended ("MPRSA"; also cited as the "National Marine Sanctuaries Act" or "NMSA"), 16 U.S.C. §1431 et seq.; and
(4) provide for the identification of marine resources and ecosystems of national significance for possible inclusion in the Sanctuary.

Article I. Effect of Designation

Section 2306 of the HINMSA requires the Secretary to develop and issue a comprehensive management plan and implementing regulations to achieve the policy and purposes of the Act, consistent with the procedures of sections 303 and 304 of the NMSA. Section 304 of the NMSA authorizes the issuance of such regulations as are necessary and reasonable to implement the designation, including managing and protecting the conservation, recreational, ecological, historical, research, educational and aesthetic resources and qualities of the Hawaiian Islands Humpback Whale National Marine Sanctuary. Section 1 of Article IV of this Designation Document lists activities subject to regulation which are those activities that may be regulated on the effective date of the regulations, or at some later date in order to implement the Sanctuary designation.

Article II. Description of the Area

The HINMSA identified a Sanctuary boundary but authorized the Secretary to modify the boundary as necessary to fulfill the purposes of the designation. The Sanctuary boundary was modified by the Secretary to encompass the submerged lands and waters off the coast of the Hawaiian Islands extending seaward from the shoreline, cutting across the mouths of rivers and streams, --

(1) to the 100-fathom (183 meter) isobath adjoining the islands of Maui, Molokai and Lanai, including Penguin Bank, but excluding the area within three nautical miles of the upper reaches of the wash of the waves on the shore of Kahoolawe Island;
(2) to the deep water area of Pailolo Channel from Cape Halawa, Molokai, to Nakalele Point, Maui, and southward;
(3) to the 100-fathom (183 meter) isobath around the island of Hawaii;
(4) to the 100-fathom (183 meter) isobath from Kailiu Point eastward to Makahuena Point, Kauai; and
(5) to the 100-fathom (183 meter) isobath from Puaena Point eastward to Mahie Point, and from the Ala Wai Canal eastward to Makapuu Point, Oahu.

Excluded from the Sanctuary boundary are the following commercial ports and small boat harbors:

Hawaii (Big Island)
Hilo Harbor
Honokohau Boat Harbor
Kawaihae Boat Harbor and Small Boat Basin
Keauhou Bay

Maui
Kahului Harbor
Lahaina Boat Harbor
Maalaea Boat Harbor

Lanai
Kaumalapau Harbor
Manele Harbor

Kauai
Hanamaulu Bay
Nawiliwili Harbor

Oahu
Ala Wai Small Boat Basin

Molokai
Hale o Lono Harbor
Kaunakakai Harbor

As specified at sections 2305(b) of the HINMSA, on January 1, 1996, the area of the marine environment within 3 nautical miles of the upper reaches of the wash of the waves on the shore of Kahoolawe Island was to become part of the Sanctuary, unless during the 3 month period immediately preceding January 1, 1996, the Secretary certified in writing to Congress that the area was not suitable for inclusion in the Sanctuary. The Secretary made such a certification in December 1995. As such, the waters surrounding Kahoolawe are not included in the Sanctuary. The HINMSA was amended in 1996 to allow the Kahoolawe Island Reserve Commission (KIRC) to request inclusion of the marine waters three miles from Kahoolawe in the Sanctuary. Upon receiving a request from the KIRC, should NOAA determine that Kahoolawe waters may be suitable for inclusion in the Sanctuary, NOAA will prepare a supplemental environmental impact statement, management plan, and implementing regulations for that inclusion. This process will include the opportunity for public comment. Further, the Governor would have the opportunity to certify his or her objection to the inclusion, or any term of that inclusion, and if this occurs, the inclusion or term will not take effect.

Article III. Characteristics of the Area That Give It Particular Value

The Hawaiian Islands comprise an archipelago which consist of eight major islands and 124 minor islands, with a total land area of 6,423 square miles, and a general coastline of 750 miles. The central North Pacific stock of endangered humpback whales, the largest of the three North Pacific stocks, estimated to be at approximately 10% of its pre-whaling abundance, uses the waters around the main Hawaiian Islands for reproductive activities including breeding, calving and nursing. The warm, calm waters around the main Hawaiian Islands provide protective

environments required for such activities. Of the known wintering and summering areas in the North Pacific used by humpback whales, the waters around the main Hawaiian Islands maintain the largest seasonally-resident population; approximately 2,000 to 3,000 humpback whales use these waters. The proximity to shore helps support an active commercial whalewatch industry, which is supported annually by millions of visitors who either directly or indirectly enjoy the Sanctuary waters.

In sections 2302(1) and (4) of the HINMSA, Congressional findings state that "many of the diverse marine resources and ecosystems within the Western Pacific region are of national significance," and "the marine environment adjacent to and between the Hawaiian Islands is a diverse and unique subtropical marine ecosystem." In addition, Congress found that the Sanctuary could be expanded to include other marine resources of national significance. The waters around the Hawaiian Islands contain 24 other species of cetaceans, the highly endangered Hawaiian monk seal, three species of sea turtles and many other marine species endemic to this environment. Coastal Hawaiian waters also support spectacular coral reef ecosystems which provide local people with an abundant source of fish and are a popular dive destination for visitors worldwide. These waters also contain a number of cultural/historical resources, including those reflecting native Hawaiian traditions and uses.

Article IV. Scope of Regulations

Section 1. Activities Subject to Regulation. In order to implement the Sanctuary designation, the following activities are subject to regulation to the extent necessary and reasonable to ensure the protection and management of the characteristics and values of the Sanctuary described above; primarily the protection and management of humpback whales and their Sanctuary habitat. Regulation may include governing the method, location, and times of conducting the activity, and prohibition of the activity, after public notice and an opportunity to comment. If a type of activity is not listed it may not be regulated, except on an emergency basis, unless Section 1 of Article IV is amended by the procedures provided in section 304(a) of the NMSA. Such activities are:

a. Approaching, or causing another vessel or object to approach, by any means a humpback whale in the Sanctuary;
b. Flying over a humpback whale in the Sanctuary in any type of aircraft except when in any designated flight corridor for takeoff or landing from an airport or runway;
c. Discharging or depositing, from within or from beyond the boundary of the Sanctuary, any material or other matter into, or that enters or could enter the Sanctuary, without, or not in compliance with, the terms or conditions of a required, valid Federal or State permit, license, lease or other authorization;
d. Drilling into, dredging or otherwise altering the seabed of the Sanctuary; or constructing, placing or abandoning any structure, material or other matter on the seabed of the Sanctuary without, or not in compliance with, the terms or conditions of a required, valid Federal or State permit, license, lease or other authorization;
e. Taking, removing, moving, catching, collecting, harvesting, feeding, injuring, destroying or causing the loss of, or attempting to take, remove, move, catch, collect, harvest, feed, injure, destroy or cause the loss of any humpback whale or humpback whale habitat;
f. Possessing within the Sanctuary a humpback whale or part thereof regardless of where taken, removed, moved, caught, collected or harvested; and
g. Interfering with, obstructing, delaying or preventing an investigation, search, seizure or disposition of seized property in connection with enforcement of the HINMSA or NMSA or any regulation or permit issued under the HINMSA or NMSA.

Section 2. Emergencies. Where necessary to prevent or minimize the destruction of, loss of, or injury to a Sanctuary resource or quality; or minimize the imminent risk of such destruction, loss or injury, any activity, including those not listed in Section 1 of this Article, is subject to immediate temporary regulation, including prohibition. If such a situation arises, the Director of NOAA's Office of Ocean and Coastal Resource Management or his or her designee shall seek to notify and consult to the extent practicable with any relevant Federal agency and the Governor of the State of Hawaii.

Article V. Effect on Leases, Permits, Licenses, and Rights

Pursuant to section 304(c)(1) of the NMSA, 16 U.S.C. §1434(c)(1), no valid lease, permit, license, approval or other authorization issued by any Federal, State, or local authority of competent jurisdiction, or any right of subsistence use or access, may be terminated by the Secretary of Commerce, or his or her designee, as a result of this designation, or as a result of any Sanctuary regulation, if such authorization or right was in existence on the effective date of Sanctuary designation (November 4, 1992).

Article VI. Alteration of This Designation

The terms of designation, as defined under section 304(a) of the NMSA, may be modified only by the procedures outlined in section 304(a) of the NMSA, including public hearings, consultation with interested Federal, State, and county agencies, review by the appropriate Congressional committees, and review and non-objection by the Governor of the State of Hawaii, and approval by the Secretary of Commerce, or his or her designee.

Hawaiian Islands Humpback Whale National Marine Sanctuary Boundary Coordinates

Appendix A to subpart Q, part 922, 15 CFR sets forth the precise boundary coordinates for the Sanctuary.

B. Implementing Regulations for the Hawaiian Islands Humpback Whale National Marine Sanctuary

[Organizationally, these regulations are revised from the proposed regulations (proposed Part 945 of 15 CFR) in furtherance of the President's Regulatory Reinvention Initiative to, among other things, consolidate duplicative regulatory provisions. Consequently, the new regulations for the most part will appear in a new subpart Q to 15 CFR Part 922 (15 CFR 922.180 - 922.187) and in Appendix A to subpart Q, and are applicable only to the HIHWNMS. Existing §§ 922.3, 922.4 and 922.46, subparts A and E of 15 CFR Part 922 are also applicable to the HIHWNMS (provisions of section 922.3 not applicable to the HIHWNMS regulations have been omitted). When the final regulations are published in the Federal Register they will be revised to include amendatory language to the Code of Federal Regulations and to eliminate sections reprinted here that presently appear in the Code of Federal Regulations.]

Subpart Q, Part 922 (Proposed Part 945)- Hawaiian Islands Humpback Whale National Marine Sanctuary

Section

Authority: Sections 302, 303, 304, 305, 306, 307, 310, and 312 of the National Marine Sanctuaries Act (NMSA) (16 U.S.C. 1431 et seq.), and sections 2304, 2305, and 2306 of the Hawaiian Islands National Marine Sanctuary Act (HINMSA), Pub. L. 102-587.

§ 922.180 Purpose.

(a) The purpose of the regulations in this subpart is to implement the designation of the Hawaiian Islands Humpback Whale National Marine Sanctuary by regulating activities affecting the resources of the Sanctuary or any of the qualities, values, or purposes for which the Sanctuary was designated, in order to protect, preserve, and manage the conservation, ecological, recreational, research, educational, historical, cultural, and aesthetic resources and qualities of the area. The regulations are intended to supplement and complement existing regulatory authorities; to facilitate to the extent compatible with the primary objective of protecting the humpback whale and its habitat, all public and private uses of the Sanctuary, including uses of Hawaiian natives customarily and traditionally exercised for subsistence, cultural, and religious purposes, as well as education, research, recreation, commercial and military activities; to reduce conflicts between compatible uses; to maintain, restore, and enhance the humpback whale and its habitat; to contribute to the maintenance of natural assemblages of humpback whales for future generations; to provide a place for humpback whales that are dependent on their Hawaiian Islands wintering

habitat for reproductive activities, including breeding, calving, and nursing, and for the long-term survival of their species; and to achieve the other purposes and policies of the HINMSA and NMSA.

(b) These regulations may be modified to fulfill the Secretary's responsibilities for the Sanctuary, including the provision of additional protections for humpback whales and their habitat, if reasonably necessary, and the conservation and management of other marine resources, qualities and ecosystems of the Sanctuary determined to be of national significance. The Secretary shall consult with the Governor of the State of Hawaii on any modification to the regulations contained in this part. For any modification of the regulations contained in this part that would constitute a change in a term of the designation, as contained in the Designation Document for the Sanctuary, the Secretary shall follow the applicable requirements of section 304(a) of the National Marine Sanctuaries Act.

§ 922.181 Boundary.

(a) Except for excluded areas described in paragraph (b) of this section, the Hawaiian Islands Humpback Whale National Marine Sanctuary consists of:

The submerged lands and waters off the coast of the Hawaiian Islands seaward from the shoreline, cutting across the mouths of rivers and streams, --

(1) to the 100-fathom (183 meter) isobath adjoining the islands of Maui, Molokai and Lanai, including Penguin Bank, but excluding the area within three nautical miles of the upper reaches of the wash of the waves on the shore of Kahoolawe Island;
(2) to the deep water area of Pailolo Channel from Cape Halawa, Molokai, to Nakalele Point, Maui, and southward;
(3) to the 100-fathom (183 meter) isobath around the Island of Hawaii;
(4) to the 100-fathom (183 meter) isobath from Kailiu Point eastward to Makahuena Point, Kauai; and
(5) to the 100-fathom (183 meter) isobath from Puaena Point eastward to Mahie Point and from the Ala Wai Canal eastward to Makapuu Point, Oahu.

(b) Excluded from the Sanctuary boundary are the following commercial ports and small boat harbors:

Hawaii (Big Island)
Hilo Harbor
Honokohau Boat Harbor
Kawaihae Boat Harbor and Small Boat Basin
Keauhou Bay

Maui
Kahului Harbor
Lahaina Boat Harbor
Maalaea Boat Harbor

Lanai
Kaumalapau Harbor
Manele Harbor

Kauai
Hanamaulu Bay
Nawiliwili Harbor

Oahu
Ala Wai Small Boat Basin

Molokai
Hale o Lono Harbor
Kaunakakai Harbor

The precise boundary of the Sanctuary appears in Appendix A of this subpart.

§ 922.3 Definitions applicable to all national marine sanctuaries.

* * *

Director means, except where otherwise specified, the Director of the Office of Ocean and Coastal Resource Management, NOAA, or designee.

* * *

Injure means to change adversely, either in the long or short term, a chemical, biological, or physical attribute of, or the viability of. This includes, but is not limited to, to cause the loss of or destroy.

* * *

Person means any private individual, partnership, corporation, or other entity; or any officer, employee, agent, department, agency, or instrumentality of the Federal Government or of any State, regional, or local unit of government, or of any foreign government.

* * *

Vessel means a watercraft of any description capable of being used as a means of transportation in/on the waters of a sanctuary.

§ 922.182 Definitions to the Hawaiian Islands Humpback Whale National Marine Sanctuary only.

(a) Acts means the Hawaiian Islands National Marine Sanctuary Act (HINMSA; sections 2301-2307 of Pub. L. 102-587), and the National Marine Sanctuaries Act (NMSA; also known as Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA), as amended, 16 U.S.C. 1431 et seq.).

Adverse impact means an impact that independently or cumulatively damages, diminishes, degrades, impairs, destroys, or otherwise harms.

Alteration of the seabed means drilling into, dredging, or otherwise altering a natural physical characteristic of the seabed of the Sanctuary; or constructing, placing, or abandoning any structure, material, or other matter on the seabed of the Sanctuary.

Habitat means those areas that provide space for individual and population growth and normal behavior of humpback whales, and include sites used for reproductive activities, including breeding, calving and nursing.

Military Activities means those military activities conducted by or under the auspices of the Department of Defense and any combined military activities carried out by the Department of Defense and the military forces of a foreign nation.

Sanctuary means the Hawaiian Islands Humpback Whale National Marine Sanctuary.

Sanctuary resource means any humpback whale, or the humpback whale's habitat within the Sanctuary.

Shoreline means the upper reaches of the wash of the waves, other than storm or seismic waves, at high tide during the season of the year in which the highest wash of the waves occurs, usually evidenced by the edge of vegetation growth, or the upper limit of debris left by the wash of the waves.

Take or taking a humpback whale means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect or injure, or to attempt to engage in any such conduct. The term includes, but is not limited to, any of the following activities: collecting any dead or injured humpback whale, or any part thereof; restraining or detaining any humpback whale, or any part thereof, no matter how temporarily; tagging any humpback whale; operating a vessel or aircraft or doing any other act that results in the disturbing or molesting of any humpback whale.

(b) Other terms appearing in the regulations in this subpart are defined at 15 CFR 922.3, and/or in the Marine Protection, Research, and Sanctuaries Act, as amended, 33 U.S.C. 1401 et seq., and 16 U.S.C. 1431 et seq.

§ 922.183 Allowed Activities.

(a) All activities except those prohibited by § 922.184 may be undertaken in the Sanctuary subject to any emergency regulations promulgated pursuant to § 922.185, subject to the interagency cooperation provisions of section 304(d) of the NMSA [16 U.S.C. §1434(d)] and § 922.187 of this subpart, and subject to the liability established by section 312 of the NMSA and § 922.46 of this Part. All activities are also subject to all prohibitions, restrictions, and conditions validly imposed by any other Federal, State, or county authority of competent jurisdiction.

(b) Included as activities allowed under the first sentence of paragraph (a) of this section are all classes of military activities, internal or external to the Sanctuary, that are being or have been conducted before the effective date of these regulations, as identified in the Final Environmental Impact Statement/Management Plan. Paragraphs (a)(1)-(5) of § 922.184 do not apply to these classes of activities, nor are these activities subject to further consultation under section 304(d) of the NMSA.

(c) Military activities proposed after the effective date of these regulations are also included as allowed activities under the first sentence of paragraph (a). Paragraphs (a)(1)-(5) of § 922.184 apply to these classes of activities unless--

(1) they are not subject to consultation under section 304(d) of the NMSA and § 922.187 of this subpart, or
(2) upon consultation under section 304(d) of the NMSA and § 922.187 of this subpart, NOAA's findings and recommendations include a statement that paragraphs (a)(1)-(5) of § 922.184 do not apply to the military activity.

(d) If a military activity described in paragraphs (b) or (c)(2) of this section is modified such that it is likely to destroy, cause the loss of, or injure a Sanctuary resource in a manner significantly greater than was considered in a previous consultation under section 304(d) of the NMSA and § 922.187 of this subpart, or if the modified activity is likely to destroy, cause the loss of, or injure any Sanctuary resource not considered in a previous consultation under section 304(d) of the NMSA and § 922.187 of this subpart, the modified activity will be treated as a new military activity under paragraph (c) of this section.

(e) If a proposed military activity subject to section 304(d) of the NMSA and § 922.187 of this subpart is necessary to respond to an emergency situation and the Secretary of Defense determines in writing that failure to undertake the proposed activity during the period of consultation would impair the national defense, the Secretary of the military department concerned may request the Director that the activity proceed during consultation. If the Director denies such a request, the Secretary of the military department concerned may decide to proceed with the activity. In such case, the Secretary of the military department concerned shall provide the Director with a written statement describing the effects of the activity on Sanctuary resources once the activity is completed.

§ 922.184 Prohibited activities.

(a) The following activities are prohibited and thus unlawful for any person to conduct or cause to be conducted.

(1) Approaching, or causing a vessel or other object to approach, within the Sanctuary, by any means, within 100 yards of any humpback whale except as authorized under the Marine Mammal Protection Act, as amended (MMPA), 16 U.S.C. 1361 et seq., and the Endangered Species Act, as amended (ESA), 16 U.S.C. 1531 et seq.;

(2) Operating any aircraft above the Sanctuary within 1,000 feet of any humpback whale except when in any designated flight corridor for takeoff or landing from an airport or runway, or as authorized under the MMPA and the ESA;

(3) Taking any humpback whale in the Sanctuary except as authorized under the MMPA and the ESA;

(4) Possessing within the Sanctuary (regardless of where taken) any living or dead humpback whale or part thereof taken in violation of the MMPA or the ESA;

(5) Discharging or depositing any material or other matter in the Sanctuary; altering the seabed of the Sanctuary; or discharging or depositing any material or other matter outside the Sanctuary if the discharge or deposit subsequently enters and injures a humpback whale or humpback whale habitat, provided that:

such activity requires a Federal or State permit, license, lease, or other authorization, and is conducted:

- without such permit, license, lease, or other authorization; OR
- not in compliance with the terms or conditions of such permit, license, lease, or other authorization.

(6) Interfering with, obstructing, delaying or preventing an investigation, search, seizure or disposition of seized property in connection with enforcement of either of the Acts or any regulations issued under either of the Acts.

(b) The prohibitions in paragraphs (a)(1)-(5) of this § 922.184 do not apply to activities necessary to respond to emergencies threatening life, property or the environment; or to activities necessary for valid law enforcement purposes. However, while such activities are not subject to paragraphs (a)(1)-(5) of this § 922.184, this paragraph (b) does not exempt the activity from the underlying prohibition or restriction under other applicable laws and regulations (e.g., MMPA, ESA, and CWA).

§ 922.4 Effect of National Marine Sanctuary Designation

The designation of a National Marine Sanctuary, and the regulations implementing it, are binding on any person subject to the jurisdiction of the United States. Designation does not constitute any claim to territorial jurisdiction on the part of the United States for designated sites beyond the U.S. territorial sea, and the regulations implementing the designation shall be applied in accordance with generally recognized principles of international law, and in accordance with treaties, conventions, and other agreements to which the United States is a party. No regulation shall apply to a person who is not a citizen, national, or resident alien of the United States, unless in accordance with:

(a) Generally recognized principles of international law;

(b) An agreement between the United States and the foreign state of which the person is a citizen; or

(c) An agreement between the United States and the flag state of the foreign vessel, if the person is a crew member of the vessel.

§ 922.185 Emergency regulations.

Where necessary to prevent or minimize the destruction of, loss of, or injury to a Sanctuary resource, or to minimize the imminent risk of such destruction, loss, or injury, any and all

activities are subject to immediate temporary regulation, including prohibition. Before issuance of such regulations the Director shall consult to the extent practicable with any relevant Federal agency and the Governor of the State of Hawaii.

§ 922.186 Penalties; appeals.

(a) Pursuant to section 307 of the NMSA, each violation of either of the Acts, or any regulation in this subpart is subject to a civil penalty of not more than $100,000. Each such violation is subject to forfeiture of property or Sanctuary resources seized in accordance with section 307 of the NMSA. Each day of a continuing violation constitutes a separate violation.

(b) Regulations setting forth the procedures governing the administrative proceedings for assessment of civil penalties for enforcement reasons, issuance and use of written warnings, and release or forfeiture of seized property appear at 15 CFR Part 904.

(c) A person subject to an action taken for enforcement reasons for violation of these regulations or either of the Acts may appeal pursuant to the applicable procedures in 15 CFR Part 904.

§ 922.187 Interagency Cooperation.

Under section 304(d) of the NMSA, federal agency actions internal or external to a national marine sanctuary, including private activities authorized by licenses, leases, or permits, that are likely to destroy, cause the loss of, or injure any sanctuary resource are subject to consultation with the Director. The federal agency proposing an action shall determine whether the activity is likely to destroy, cause the loss of, or injure a Sanctuary resource. To the extent practicable, consultation procedures under section 304(d) of the NMSA may be consolidated with interagency cooperation procedures required by other statutes, such as the ESA. The Director will attempt to provide coordinated review and analysis of all environmental requirements.

§ 922.46 Response costs and damages.

Under section 312 of the NMSA, 16 U.S.C. 1443, any person who destroys, causes the loss of, or injures any Sanctuary resource is liable to the United States for response costs and damages (plus interest) resulting from such destruction, loss, or injury, and any vessel used to destroy, cause the loss of, or injure any Sanctuary resource is liable *in rem* to the United States for response costs and damages resulting from such destruction, loss, or injury.

Appendix A to subpart Q -- Hawaiian Islands Humpback Whale National Marine Sanctuary Boundary Coordinates

Appendix 1: Hawaiian Islands Humpback Whale National Marine Sanctuary Boundary Coordinates

Kauai

Points	Latitude (deg,min,sec)	Longitude (deg,min,sec)
1.	22,13,37	159,34,57
2.	22,16,42	159,36,4
3.	22,17,13	159,35,16
4.	22,17,25	159,34,34
5.	22,17,15	159,33,2
6.	22,16,59	159,32,3
7.	22,16,34	159,31,31
8.	22,15,47	159,31,19
9.	22,15,41	159,31,5
10.	22,16,14	159,30,37
11.	22,16,6	159,29,46
12.	22,15,50	159,29,20
13.	22,15,52	159,28,32
14.	22,15,31	159,27,54
15.	22,15,25	159,27,17
16.	21,52,0	159,22,56
17.	21,59,17	159,18,25
18.	21,58,42	159,18,51
19.	21,58,28	159,18,56
20.	21,58,10	159,18,54
21.	21,58,4	159,18,32
22.	21,57,5	159,18,41
23.	21,56,43	159,19,4
24.	21,56,13	159,19,39
25.	21,55,29	159,20,36
26.	21,54,48	159,21,12
27.	21,54,1	159,21,27
28.	21,53,45	159,21,46
29.	21,53,27	159,22,14
30.	21,53,1	159,22,32
31.	21,52,44	159,22,37
32.	21,52,13	159,22,49
33.	21,51,45	159,23,18
34.	21,51,43	159,23,50
35.	21,51,49	159,24,26
36.	21,51,53	159,24,48
37.	21,51,51	159,25,12
38.	21,51,42	159,25,41
39.	21,51,15	159,25,58
40.	21,50,57	159,26,15
41.	21,52,17	159,26,48
42.	22,12,53	159,18,4
43.	22,15,26	159,26,20
44.	22,15,11	159,25,52
45.	22,15,18	159,24,50
46.	22,15,22	159,24,10
47.	22,15,21	159,22,53
48.	22,15,6	159,22,34
49.	22,15,6	159,21,54
50.	22,15,7	159,21,23
51.	22,14,30	159,20,55
52.	22,14,18	159,20,31
53.	22,14,22	159,19,54
54.	22,13,21	159,18,43
55.	22,12,31	159,17,46
56.	22,12,18	159,17,17
57.	22,11,14	159,17,5
58.	22,10,29	159,16,42
59.	22,9,57	159,16,25
60.	22,9,25	159,15,42
61.	22,8,34	159,15,39
62.	22,0,15	159,18,48
63.	22,7,4	159,16,37
64.	22,6,17	159,16,31
65.	22,5,51	159,16,13
66.	22,5,4	159,16,47
67.	22,4,18	159,17,32
68.	22,3,32	159,17,28
69.	22,3,15	159,17,23
70.	22,2,56	159,17,33
71.	22,2,48	159,17,48
72.	22,2,33	159,18,4
73.	22,2,16	159,18,24
74.	22,1,57	159,18,46
75.	22,1,51	159,19,11
76.	22,1,26	159,19,24
77.	22,0,59	159,19,8
78.	22,0,49	159,18,54
79.	22,0,0	159,18,47
80.	21,59,40	159,18,27

Oahu (North)

Points	Latitude (deg,min,sec)	Longitude (deg,min,sec)
1.	21,36,22	158,6,37
2.	21,38,41	158,8,39
3.	21,39,1	158,8,7
4.	21,39,24	158,7,44
5.	21,39,43	158,7,44
6.	21,40,12	158,7,27
7.	21,40,27	158,7,38
8.	21,40,45	158,7,21
9.	21,40,46	158,6,56
10.	21,41,7	158,6,41
11.	21,41,29	158,6,16
12.	21,41,44	158,6,13
13.	21,42,55	158,5,13

14.	21,43,54	158,3,58
15.	21,44,22	158,3,22
16.	21,45,3	158,2,0
17.	21,45,15	158,1,19
18.	21,45,34	158,0,20
19.	21,37,14	157,51,34
20.	21,45,34	157,59,17
21.	21,45,34	157,58,37
22.	21,45,29	157,57,34
23.	21,44,55	157,56,18
24.	21,44,33	157,55,30
25.	21,44,13	157,54,40
26.	21,43,33	157,53,45
27.	21,41,34	157,53,12
28.	21,38,36	157,52,38
29.	21,37,54	157,53,3
30.	21,37,48	157,52,38
31.	21,35,47	157,50,11
32.	21,33,48	157,51,58
33.	21,37,50	157,52,10
34.	21,36,43	157,50,54

Oahu (South)

Points	Latitude (deg,min,sec)	Longitude (deg,min,sec)
1.	21,15,38	157,51,1
2.	21,14,18	157,42,17
3.	21,14,9	157,42,46
4.	21,13,27	157,43,13
5.	21,13,31	157,43,47
6.	21,14,44	157,43,59
7.	21,14,47	157,44,24
8.	21,14,35	157,44,54
9.	21,14,34	157,45,32
10.	21,14,11	157,46,52
11.	21,14,14	157,47,35
12.	21,13,55	157,47,58
13.	21,14,0	157,48,28
14.	21,14,29	157,48,53
15.	21,14,40	157,49,34
16.	21,15,0	157,50,16
17.	21,15,25	157,50,51
18.	21,15,50	157,51,14
19.	21,17,8	157,50,54
20.	21,18,50	157,39,6
21.	21,19,53	157,36,4
22.	21,19,34	157,35,6
23.	21,18,55	157,34,21
24.	21,18,47	157,33,53
25.	21,17,52	157,33,21
26.	21,17,36	157,33,32
27.	21,17,3	157,33,32
28.	21,16,34	157,34,3
29.	21,15,52	157,34,46
30.	21,15,56	157,35,19
31.	21,15,20	157,35,44
32.	21,15,13	157,36,0
33.	21,15,22	157,36,57
34.	21,15,33	157,38,20
35.	21,15,21	157,38,51
36.	21,15,20	157,40,5
37.	21,15,23	157,40,53
38.	21,14,56	157,42,6

Maui

Points	Latitude (deg,min,sec)	Longitude (deg,min,sec)
1.	20,51,18	157,44,40
2.	20,52,9	157,44,16
3.	20,52,37	157,44,38
4.	20,52,47	157,45,24
5.	20,53,38	157,46,3
6.	20,55,27	157,45,21
7.	20,56,22	157,45,43
8.	20,57,2	157,45,17
9.	20,57,36	157,44,31
10.	20,59,2	157,44,19
11.	20,59,54	157,43,33
12.	21,1,19	157,43,14
13.	21,1,45	157,42,11
14.	21,2,56	157,42,2
15.	21,3,7	157,41,32
16.	21,3,3	157,40,43
17.	21,4,2	157,39,39
18.	21,4,49	157,39,57
19.	21,5,16	157,39,30
20.	21,5,9	157,38,21
21.	21,5,20	157,37,59
22.	21,5,52	157,37,54
23.	21,6,48	157,36,30
24.	21,7,34	157,35,24
25.	21,8,11	157,33,41
26.	21,8,56	157,33,1
27.	20,57,10	157,33,16
28.	20,56,33	157,33,42
29.	20,55,10	157,33,45
30.	20,53,29	157,37,14
31.	20,51,57	157,40,53
32.	20,51,40	157,42,12
33.	20,50,56	157,42,54
34.	20,58,18	157,22,27
35.	21,0,19	157,19,45
36.	21,1,25	157,18,43

37.	21,1,7	157,19,36
38.	21,0,44	157,20,30
39.	21,0,0	157,19,0
40.	20,59,29	157,19,28
41.	20,59,29	157,20,57
42.	20,59,55	157,21,29
43.	21,0,38	157,21,26
44.	21,0,23	157,21,57
45.	21,0,16	157,22,41
46.	21,0,28	157,23,29
47.	21,0,26	157,24,32
48.	21,0,3	157,25,23
49.	20,59,24	157,25,20
50.	20,58,53	157,25,47
51.	20,58,50	157,26,21
52.	20,58,22	157,25,22
53.	20,58,49	157,23,17
54.	20,58,43	157,21,50
55.	20,58,11	157,23,46
56.	20,57,56	157,26,49
57.	20,57,59	157,28,30
58.	20,57,51	157,29,44
59.	20,57,25	157,31,42
60.	20,56,32	157,29,51
61.	20,56,1	157,29,56
62.	20,55,54	157,31,46
63.	21,17,9	157,17,24
64.	21,9,41	157,31,30
65.	21,9,58	157,30,9
66.	21,9,58	157,29,39
67.	21,9,29	157,28,36
68.	21,9,33	157,27,5
69.	21,10,2	157,23,53
70.	21,10,51	157,21,43
71.	21,12,41	157,19,17
72.	21,14,54	157,18,44
73.	21,16,42	157,18,25
74.	21,17,13	157,16,13
75.	21,16,35	157,14,39
76.	21,16,2	157,13,14
77.	21,3,36	157,10,57
78.	21,3,41	157,11,50
79.	21,3,13	157,12,22
80.	21,2,25	157,12,51
81.	21,2,7	157,13,43
82.	21,1,51	157,14,11
83.	21,1,59	157,14,37
84.	21,1,56	157,15,12
85.	21,1,36	157,16,5
86.	21,1,42	157,17,0
87.	21,1,16	157,17,27
88.	21,0,51	157,18,8
89.	21,0,59	157,18,35
90.	21,3,21	157,3,59
91.	20,53,46	157,5,35
92.	20,54,59	157,5,28
93.	20,55,29	157,5,31
94.	20,56,31	157,4,8
95.	20,56,58	157,3,32
96.	20,57,37	157,2,45
97.	20,58,22	157,2,7
98.	20,58,40	157,1,28
99.	20,59,26	157,1,14
100.	21,0,24	157,1,25
101.	21,1,15	157,1,30
102.	21,1,50	157,1,59
103.	21,2,20	157,2,19
104.	21,3,0	157,3,4
105.	21,3,6	157,4,51
106.	21,3,41	157,6,17
107.	21,3,9	157,8,46
108.	21,3,29	157,10,22
109.	21,15,48	157,11,4
110.	21,15,27	157,9,24
111.	21,15,2	157,8,29
112.	21,14,23	157,6,12
113.	21,13,56	157,5,10
114.	21,13,55	157,4,25
115.	21,13,47	157,4,1
116.	21,13,7	157,3,25
117.	21,13,38	157,2,54
118.	21,13,35	157,1,42
119.	21,13,1	157,1,2
120.	21,13,10	157,0,15
121.	21,12,43	156,59,54
122.	21,13,22	156,59,8
123.	21,13,46	156,58,25
124.	21,13,14	156,57,40
125.	20,49,18	157,1,5
126.	20,44,4	156,48,49
127.	20,43,18	156,45,48
128.	20,43,44	156,46,17
129.	20,43,41	156,47,27
130.	20,44,42	156,48,49
131.	20,44,23	156,49,38
132.	20,44,23	156,51,9
133.	20,43,37	156,51,54
134.	20,44,19	156,47,48
135.	20,43,6	156,52,31
136.	20,42,16	156,53,12
137.	20,42,39	156,54,43
138.	20,42,47	156,56,25
139.	20,42,54	156,57,39
140.	20,43,56	156,59,6
141.	20,45,16	157,0,3
142.	20,46,37	157,0,48
143.	20,47,38	157,0,40
144.	20,50,43	157,2,39

145.	20,51,53	157,4,27	199.	21,0,44	156,21,34
146.	20,52,31	157,4,58	200.	21,1,0	156,18,8
147.	21,12,49	156,43,45	201.	20,33,7	156,23,38
148.	21,11,36	156,53,20	202.	20,36,3	156,10,43
149.	21,12,38	156,56,44	203.	20,35,46	156,13,13
150.	21,12,1	156,56,8	204.	20,35,11	156,14,55
151.	21,12,7	156,55,3	205.	20,34,4	156,16,39
152.	21,12,5	156,54,17	206.	20,33,28	156,17,29
153.	21,11,36	156,54,2	207.	20,33,49	156,19,24
154.	21,12,3	156,52,56	208.	20,33,36	156,20,59
155.	21,11,48	156,52,6	209.	20,33,18	156,22,7
156.	21,12,7	156,51,38	210.	20,35,8	156,27,59
157.	21,11,40	156,51,34	211.	20,33,46	156,26,9
158.	21,11,59	156,50,44	212.	20,36,27	156,28,24
159.	21,12,30	156,49,55	213.	20,36,31	156,28,57
160.	21,12,26	156,49,26	214.	20,35,53	156,28,41
161.	21,12,15	156,48,37	215.	20,59,43	156,16,25
162.	21,12,22	156,47,56	216.	20,58,42	156,13,53
163.	21,11,52	156,47,27	217.	20,54,32	156,9,10
164.	21,12,34	156,46,42	218.	20,54,21	156,8,16
165.	21,13,16	156,45,40	219.	20,53,8	156,6,17
166.	21,13,32	156,45,3	220.	20,51,25	156,5,7
167.	21,13,1	156,44,26	221.	20,51,5	156,4,18
168.	21,12,30	156,43,4	222.	20,50,35	156,3,57
169.	21,11,56	156,42,56	223.	20,49,56	156,1,50
170.	21,12,11	156,41,58	224.	20,48,43	156,0,52
171.	21,11,59	156,41,5	225.	20,48,40	155,59,55
172.	21,11,13	156,39,51	226.	20,48,1	155,58,53
173.	21,10,31	156,39,30	227.	20,37,34	156,4,45
174.	21,8,6	156,40,32	228.	20,47,11	155,58,0
175.	21,7,8	156,40,11	229.	20,46,22	155,57,35
176.	20,36,4	156,29,59	230.	20,45,24	155,57,23
177.	20,38,57	156,34,30	231.	20,44,30	155,57,15
178.	20,39,50	156,35,32	232.	20,42,58	155,57,6
179.	20,40,33	156,36,5	233.	20,41,38	155,58,20
180.	20,41,22	156,36,34	234.	20,40,50	155,59,12
181.	20,42,5	156,36,54	235.	20,40,5	155,59,51
182.	20,42,12	156,38,0	236.	20,39,35	156,0,54
183.	20,42,51	156,39,38	237.	20,38,46	156,1,46
184.	20,43,14	156,41,1	238.	20,38,0	156,2,24
185.	20,43,33	156,42,11	239.	20,37,37	156,3,23
186.	20,44,11	156,42,31	240.	20,37,29	156,5,49
187.	20,43,52	156,43,25	241.	20,36,39	156,6,50
188.	20,41,22	156,42,31	242.	20,36,21	156,7,54
189.	20,41,3	156,43,0	243.	20,35,59	156,8,55
190.	20,42,12	156,44,22	244.	20,53,1	157,38,48
191.	20,43,2	156,44,43	245.	20,54,7	157,35,43
192.	21,0,44	156,18,53	246.	20,56,28	157,32,7
193.	21,4,31	156,37,39	247.	20,58,27	157,24,17
194.	21,4,31	156,35,32	248.	20,58,3	157,25,19
195.	21,3,41	156,33,57	249.	21,3,24	157,7,44
196.	21,2,5	156,31,13	250.	20,55,55	157,30,55
197.	21,1,4	156,27,27	251.	20,50,44	157,2,9
198.	21,1,15	156,22,39	252.	21,1,8	156,24,34

253.	20,34,31	156,26,58
254.	20,58,12	156,12,43
255.	20,52,7	157,40,28
256.	20,54,59	157,34,4

Big Island (Hawaii)

Points	Latitude (deg,min,sec)	Longitude (deg,min,sec)
1.	19,33,54	156,0,19
2.	19,34,42	156,0,33
3.	19,35,21	156,0,35
4.	19,39,49	156,2,29
5.	19,43,34	156,4,26
6.	19,46,7	156,5,57
7.	19,47,17	156,6,34
8.	19,48,3	156,6,19
9.	19,48,42	156,6,28
10.	19,51,28	156,4,33
11.	19,53,15	156,2,25
12.	19,55,43	155,58,13
13.	19,53,47	156,1,26
14.	19,54,6	156,1,1
15.	19,54,8	156,0,3
16.	19,55,8	155,59,14
17.	19,56,11	155,57,41
18.	19,56,36	155,57,19
19.	19,57,19	155,56,44
20.	19,57,56	155,56,18
21.	19,58,22	155,55,56
22.	19,58,39	155,55,2
23.	19,58,45	155,54,36
24.	19,58,57	155,54,9
25.	19,59,15	155,53,37
26.	19,59,31	155,52,58
27.	20,0,20	155,52,25
28.	20,1,4	155,52,25
29.	20,1,36	155,52,4
30.	20,2,24	155,52,17
31.	20,3,14	155,52,25
32.	20,5,50	155,54,44
33.	19,20,32	155,53,38
34.	19,7,28	155,55,34
35.	19,9,6	155,55,49
36.	19,9,52	155,55,42
37.	19,10,57	155,55,16
38.	19,12,49	155,54,28
39.	19,13,29	155,54,32
40.	19,14,22	155,54,24
41.	19,15,2	155,54,24
42.	19,16,17	155,54,1
43.	19,18,0	155,53,47
44.	19,19,22	155,53,49
45.	19,22,49	155,54,43
46.	19,25,22	155,55,33
47.	19,26,21	155,55,39
48.	19,27,14	155,56,9
49.	19,28,41	155,56,42
50.	19,29,1	155,57,14
51.	19,29,25	155,58,9
52.	19,30,23	155,59,3
53.	20,15,49	155,43,33
54.	20,13,22	155,56,15
55.	20,7,10	155,55,14
56.	20,9,21	155,55,44
57.	20,12,43	155,56,28
58.	20,14,41	155,56,12
59.	20,15,34	155,55,53
60.	20,16,21	155,55,28
61.	20,16,47	155,54,54
62.	20,17,42	155,53,56
63.	20,18,11	155,52,3
64.	20,18,9	155,51,28
65.	20,17,41	155,49,45
66.	20,16,39	155,45,47
67.	20,16,23	155,44,18
68.	20,14,44	155,43,7
69.	20,14,5	155,42,57
70.	20,13,54	155,41,55
71.	20,12,57	155,41,28
72.	20,12,8	155,40,58
73.	20,11,32	155,39,37
74.	18,51,25	155,41,26
75.	18,52,3	155,41,45
76.	18,52,36	155,41,44
77.	18,53,23	155,41,35
78.	18,54,14	155,41,39
79.	18,54,42	155,41,28
80.	18,55,42	155,41,27
81.	18,56,26	155,41,51
82.	18,56,41	155,42,16
83.	18,57,0	155,42,41
84.	18,57,33	155,43,15
85.	18,58,7	155,44,2
86.	18,58,14	155,44,49
87.	18,58,36	155,45,43
88.	18,58,56	155,46,16
89.	18,59,32	155,47,7
90.	19,0,38	155,48,26
91.	19,0,49	155,49,37
92.	19,1,9	155,50,36
93.	19,1,22	155,51,43
94.	19,2,4	155,52,58
95.	19,2,39	155,53,14
96.	19,3,40	155,53,45

97.	19,4,52	155,54,50	151.	19,15,55	155,16,18
98.	19,5,51	155,55,4	152.	19,15,29	155,17,1
99.	18,52,27	155,40,26	153.	19,15,42	155,17,30
100.	18,53,12	155,39,32	154.	19,14,37	155,18,51
101.	19,3,35	155,32,20	155.	19,13,55	155,20,10
102.	19,12,28	155,21,5	156.	20,3,22	155,18,51
103.	19,11,47	155,22,47	157.	20,1,48	155,15,39
104.	19,10,38	155,25,12	158.	19,59,17	155,11,13
105.	19,9,34	155,26,18	159.	19,58,42	155,10,31
106.	19,9,4	155,26,31	160.	19,57,40	155,0,0
107.	19,8,29	155,27,44	161.	19,56,17	155,7,57
108.	19,8,3	155,29,20	162.	19,55,18	155,6,35
109.	19,7,5	155,30,35	163.	19,54,1	155,5,14
110.	19,6,29	155,31,20	164.	19,52,12	155,3,54
111.	19,5,36	155,32,6	165.	19,51,0	155,3,25
112.	19,4,35	155,32,19	166.	19,49,52	155,3,25
113.	19,2,52	155,32,48	167.	19,48,56	155,3,5
114.	19,1,15	155,34,29	168.	19,45,25	154,58,59
115.	19,0,24	155,34,57	169.	19,48,15	155,2,14
116.	18,59,29	155,35,28	170.	19,47,49	155,2,33
117.	18,58,17	155,35,37	171.	19,47,21	155,2,7
118.	19,1,53	155,33,29	172.	19,47,6	155,1,27
119.	18,57,6	155,36,16	173.	19,46,37	155,1,0
120.	18,56,15	155,36,46	174.	19,46,20	155,0,39
121.	18,55,15	155,37,19	175.	19,46,0	154,59,28
122.	18,54,31	155,38,32	176.	19,44,37	154,58,34
123.	20,4,41	155,21,53	177.	19,44,14	154,58,33
124.	20,10,40	155,38,43	178.	19,43,15	154,58,30
125.	20,10,23	155,38,3	179.	19,42,40	154,58,9
126.	20,9,50	155,37,34	180.	19,41,52	154,58,12
127.	20,9,53	155,37,15	181.	19,41,34	154,57,43
128.	20,9,23	155,36,14	182.	19,41,13	154,57,17
129.	20,8,46	155,34,38	183.	19,40,39	154,57,24
130.	20,8,49	155,34,0	184.	19,39,54	154,57,24
131.	20,8,13	155,32,46	185.	19,39,27	154,56,58
132.	20,8,13	155,31,23	186.	19,39,15	154,56,49
133.	20,7,40	155,29,41	187.	19,38,38	154,56,55
134.	20,7,6	155,27,29	188.	19,38,17	154,56,58
135.	20,6,45	155,26,3	189.	19,37,13	154,56,10
136.	20,6,9	155,24,40	190.	19,33,26	154,52,7
137.	20,5,29	155,23,10	191.	19,35,24	154,55,6
138.	20,3,59	155,20,4	192.	19,34,18	154,53,24
139.	19,17,53	155,5,13	193.	19,33,2	154,50,56
140.	19,15,52	155,8,36	194.	19,32,35	154,49,4
141.	19,14,52	155,10,31	195.	19,31,49	154,48,13
142.	19,14,57	155,11,7	196.	19,30,49	154,48,4
143.	19,15,4	155,11,39	197.	19,29,42	154,48,23
144.	19,14,58	155,11,50	198.	19,28,51	154,48,58
145.	19,15,1	155,12,18	199.	19,28,14	154,49,31
146.	19,15,15	155,12,55	200.	19,27,52	154,49,57
147.	19,15,9	155,13,28	201.	19,27,15	154,50,25
148.	19,15,32	155,14,10	202.	19,26,37	154,51,21
149.	19,15,31	155,14,55	203.	19,23,48	154,55,11
150.	19,15,50	155,15,42	204.	19,22,57	154,56,10

205.	19,21,23	154,57,50
206.	19,19,34	155,1,22

Ports and Harbor Exclusions (points mark outer boundary of harbor)

Points	Latitude (deg,min,sec)	Longitude (deg,min,sec)
Ala Wai Harbor (Oahu)		
1	21,17,5	157,50,55
2	21,17,2	157,50,34
Hilo Bay (Big Island)		
1	19,44,37	155,5,35
2	19,44,44	155,4,40
Honokohau Harbor (Big Island)		
1	19,40,23	156,1,50
2	19,40,11	156,1,56
Kawaihae Harbor (Big Island)		
1	20,2,25	155,50,12
2	20,2,36	155,50,7
Keauhou Bay (Big Island)		
1	19,33,43	155,58,8
2	19,34,2	155,58,9
Kahului Harbor (Maui)		
1	20,54,12	156,28,36
2	20,54,13	156,28,28
Lahaina Harbor (Maui)		
1	20,52,29	156,40,54
2	20,52,29	156,40,53
Maalea Harbor (Maui)		
1	20,47,36	156,30,49
2	20,47,42	156,30,44
Hale o Lono Harbor (Molokai)		
1	21,5,15	157,15,8
2	21,5,15	157,15,5
Kaunakakai Harbor (Molokai)		
1	21,5,25	157,1,46
2	21,5,0	157,2,8
3	21,4,49	157,1,51
4	21,5,18	157,1,25
Kaumalapau Harbor (Lanai)		
1	20,47,12	156,59,41
2	20,47,19	156,59,42
Manele Harbor (Lanai)		
1	20,44,46	156,53,24
2	20,44,44	156,53,22
Hanamaula Bay (Kauai)		
1	21,59,49	159,20,6
2	22,0,3	159,20,8
Nawiliwili Harbor (Kauai)		
1	21,57,3	159,21,3
2	21,57,29	159,20,20

THIS PAGE INTENTIONALLY LEFT BLANK